SEVENTEENTH ANNUAL REPORT

OF THE

OHIO SOCIETY

OF

Surveyors and Civil Engineers

BEING THE

TRANSACTIONS OF THE SOCIETY

AT ITS

SEVENTEENTH ANNUAL MEETING

HELD IN

Dayton, Ohio, February 25, 26, and 27, 1896

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THE OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS, as a body, is not responsible for the statements and opinions advanced in any of the papers published in this report.

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SEVENTEENTH ANNUAL REPORT

OF THE

OHIO SOCIETY

OF

Surveyors and Civil Engineers

MEETINGS HELD AT THE BUILDERS' EXCHANGE
DAYTON, OHIO.

OUTLINE OF PROCEEDINGS.

Tuesday, February 25, 1896.

AFTERNOON SESSION.

Under the guidance of the Local Committee the Society visited the following places of interest: Dayton Bicycle Club, The City Railway and White Line Electric Power Houses, Soldiers' Home and Electric Light Plant.

EVENING SESSION.

Vice President F. M. Turner called the meeting to order and introduced Mayor C. G. McMillen, who addressed the Society, welcoming the members to the city.

On account of the resignation of President John L. Culley, Vice President F. M. Turner acted as President and delivered the annual address.

The annual report of the Secretary was presented, and upon motion was adopted.

The annual report of the Treasurer was presented, and was by motion referred to the Board of Trustees for examination.

Upon motion the Trustees were given further time to make their report.

The Secretary stated, for the benefit of all, that the Society always extends to all those present and interested in the work an invitation to take part in the discussions, and to ask questions upon any topic that may be before the Society.

Mr. H. W. McDonald read a paper on "Improvement at Street Intersections," which was followed by an interesting and valuable discussion.

A paper on "Portland Cement Construction," by Professor S. B. Newberry, was read and illustrated by samples of cement briquettes.

The Secretary read the paper on "Some Tests of Natural Cement" prepared and sent to the meeting by Mr. I. C. Brewer, jr., who could not be present.

These papers on Cements were followed by a very full discussion.

The report of the Committee on Legislation was postponed until the following day.

Wednesday, February 26, 1896.

MORNING SESSION.

President Turner not being able to be present, Mr. C. N. Brown was called to the chair as temporary chairman for this session.

The report of the Committee on Civil, Mechanical and Electrical Engineering was presented by the chairman, Mr. F. M. Lillie.

A supplementary report was also made by Mr. J. B. Strawn, a member of the committee.

Mr. H. L. Weber read a paper on "Notes," and illustrated it with a large collection of elegant maps, plans, working drawings, profiles, photographs, note books, record books, blanks and specifications.

Mr. E. F. Layman, chairman of the Committee on Legislation, reported for the committee a bill that the committee had

prepared to be presented to the Legislature, relating to the practice of surveying in Ohio. After considerable discussion it was, upon motion, referred to a special committee of five, to be reported back at the evening session.

The chair appointed as the committee Messrs. Layman, Cellarius, Strawn, Davis and Payne.

There being no report from the Committee on Land Surveying and Drainage, Mr. Weber, upon request, occupied the time with a description of some of the maps he had on exhibition.

A paper, "Suggestions for Improvement," by Benjamin Thompson, was read by the Secretary.

Upon motion, the chair appointed Messrs. J. B. Weddell, H. W. McDonald, and J. L. Gilpatrick as the Committee on Nominations, to report at a later session.

Mr. Wm. Dunn exhibited a curious old instrument, evidently intended for the use of Navigators or Surveyors, bearing the date of 1707.

The President was instructed, by motion, to appoint four members to act as an Auditing Committee of the Treasurer's report, in lieu of the Trustees, who are not present.

The President appointed Messrs. J. T. Buck, F. M. Davisson, J. W. Atkinson and F. A. Bone.

AFTERNOON SESSION.

President Turner in the chair.

Dr. Edward Orton delivered an address on the subject of "Sewage Disposal." Discussion was postponed until the evening session.

The convention then adjourned to visit the following places under the direction of the Local Committee: Dayton Water Works, First and Second Street Hydraulic Lift Bridges, Stillwell & Bierce and Smith-Vaile Manufacturing Co., Barney & Smith Car Co., Dayton Ice Manufacturing and Cold Storage Company's Plant, and Dayton Gas Light and Coke Company's Plant.

EVENING SESSION.

President Turner not being present, C. N. Brown was elected temporary chairman for the session.

Mr. Geo. H. Frost, Manager Engineering News, delivered an address on "Sewage Disposal." The discussion following covered both Dr. Orton's and Mr. Frost's papers.

Mr. E. F. Layman, as chairman of the special committee of five, read the bill they had prepared and explained how it differed from the first draft submitted. After discussion it was moved, seconded and the motion carried, that the bill be adopted and placed in the hands of the Committee on Legislation, with instructions to consult an attorney as to the legal features, make such corrections as may be necessary to meet any proper legal form, and then to present it at Columbus for action by the present Legislature.

Mr. Weddell, as Chairman of the committee on nominations, presented their report which was, upon motion, adopted, and the Secretary ordered to cast the vote of the Society for the members named for the respective offices.

Mr. J. B. Strawn read a paper on the subject of "A Combined Water and Light Plant."

Thursday, February 27; 1896.

MORNING SESSION.

In the absence of President Turner, Mr. J. B. Strawn was elected temporary chairman for the session.

Mr. C. E. DeWitt read a paper on the subject of "Some Features of the Port Clinton Water Works," and illustrated the same with a number of drawings.

Mr. J. B. Davis read a paper on the subject of "A New Solar Transit, and the Principle on which its Construction and Operation are Based," illustrating the same with one of the instruments.

Mr. Chas. A. Judson read a paper describing "A Timber Trestle" which had come under his observation, illustrating his paper with a drawing.

At the close of the discussion of the paper a motion was made, seconded and carried, that a committee of three be appointed to report at the next annual meeting, such measures as in their judgment may be expedient for the passage of a law providing for a railroad commission in the State of Ohio, based upon the Massachusetts railroad commission law.

The Chair appointed Messrs. E. F. Layman, J. A. Hanlon and E. D. Wileman.

The following resolution was adopted:

Resolved, That the Secretary be and is hereby authorized to transmit to the proper committees of the Senate and the House of Representatives of the General Assembly of the State of Ohio, a certified copy of the action of this Society with reference to the bill for the licensing of land surveyors, and that each member of this society be and is hereby requested to address a personal letter to the Representative and Senator from his district, requesting him to use all honorable means to secure the passage of said bill.

The following committee was appointed to have the above mentioned bill properly presented to the General Assembly: Messrs. E. F. Layman, F. J. Cellarius, Wm. Dunn and J. F. Brown.

By motion the Secretary was authorized to spend a sum not exceeding Fifty Dollars for necessary legal expenses and sundry expenses for the passage of the bill.

Mr. E. A. Kemmeler presented the report of the Trustees. Upon motion it was received, the recommendations approved and the report ordered spread upon the minutes of the Society.

The following persons were duly elected to membership of the Society: Chas. F. Vance, Troy, O.; L. A. Dillon, Hamilton, O.; Robt. E. Kline, Dayton, O.; Jos. Dannheiser, Cincinnati, O.; Geo. Taylor, Lima, O.

The committee appointed to draft resolutions on the death of A. A. Graham submitted their report, which was unanimously adopted.

The Secretary notified the Society that unless some action is taken by the Board of Trustees, that the next annual meet-

ing of the Society will be held, according to the constitution, at Columbus, Ohio.

Resolutions were unanimously adopted giving a vote of thanks to the Local Committee, who have provided so royal a reception for the Society, to the several street car companies who have furnished free transportation, and to all others who have done so much to make our visit to the Gem City a memorable one.

The Society then adjourned.

In the afternoon the members were conducted by the Local Committee to the Dayton Club, the National Cash Register Works, Sewer Outlet and the Pumping Station.

In the evening the Society was entertained at a complimentary banquet at the Hotel Atlas by the Dayton friends. Numerous appropriate toasts were proposed and responded to, and the occasion was a very happy ending of a most enjoyable and profitable meeting.

REPORT OF SECRETARY.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—I herewith respectfully submit the following report of matters relating to the Society: There are on the roll of membership 119 names of active and three associate members; of this number 53 have paid their dues in full, 67 owe for 1895, 41 for 1894 and 12 for 1893. As for a number of previous years, sixteen hundred reports were printed this year. This number, of course, after providing for our exchanges and those of our members who have paid up, still leaves quite a number on hand, but the additional expense of two or three hundred reports is not much, and there are many calls for back reports from outsiders as the years go by, who are willing to pay for them. Besides, the extra copies make it possible to complete the files of members who join subsequently and at very little expense. In fact, our files of three different years have become exhausted and we are continually having calls for them from members and others, which, of course, we are unable to meet. This difficulty would have been avoided had extra numbers been printed at the time publications were issued.

There have been received during the year and sent to the members whose dues were paid the publications of the following societies: Michigan Engineering Society; Engineering Societies of the University of Michigan; Iowa Society of Civil Engineers and Surveyors; Association of Ontario Land Surveyors; Connecticut Association of Civil Engineers and Surveyors, Illinois Society of Engineers and Surveyors and Indiana Engineering Society. The members will also receive the publications of The Engineering Society of the South and of The University of Illinois as soon as they are issued. It is expected that the members will also receive the publications of one or two other college societies with whom we are negotiating. The attention of the members is called to these excellent publications which are alone worth more than the annual dues paid by the members.

I have to report the death of Mr. A. A. Graham, an honorary member of the Society, who died February 5, 1896, at Albuquerque, New Mexico, where he went for his health some three years ago. He was for some time Secretary of The Ohio Archaeological Association, and was made an honorary member of the society in January, 1892.

The postponement of our annual meeting this year to the present date was due to a slight misunderstanding of the local committee and myself. A letter relating to the meeting was received by the committee, and a reply, though sent, was never received by the Secretary, so that some three weeks of valuable time was lost; when the difficulty was finally located, it seemed best to pitch upon the time finally selected.

The publication of the annual report was delayed beyond the usual time for the reason that at the beginning of the year we did not have sufficient funds to take care of it. We began the year with a number of obligations, while the collections of back dues were especially slow and arduous. Many wrote that times were hard, that there was little work, and that they would pay up as soon as possible, but did not want to be dropped from the roll. Advertisers, too, talked in about the same strain; and when a thorough canvass had been made of the field, it was found that the advertisements for the Sixteenth Report amounted to but $135; although this was slightly more than the amount received the previous year, it did not warrant us in issuing as elaborate a report. The Fifteenth Annual Report cost $315, while the one just issued will cost but $196, or about $60 more than the amount that will be received from ads.

The payment of back dues by a few members will enable us to start the year with a clean sheet, permitting the report to be gotten out early in the season, which will be much more satisfactory to all concerned.

Your Secretary pleads guilty to the fact that he was not able for some months to give the society work the attention that it ought to have had. He accepted the office a year ago, however, under protest and against his better judgment. If the experience of the past year demonstrates to you quite clearly that

he was right a year ago in stating that he ought to be relieved from the office because he did not have time to do it justice, the disappointment of the past year will not have been entirely in vain.

To allude again to the annual reports, in order to make them what they ought to be, that is, so that they will contain full accounts of the meetings, the best papers in full, with discussions of them and with appropriate illustrations, the whole to be done in appropriate style, it is necessary that we secure a good line of advertisements. These do not come of themselves; in fact, they require quite a large amount of soliciting. To illustrate: For the $135 worth of advertising secured for the last report, probably not less than one hundred letters were written. While it is difficult for the Secretary to procure a sufficient number alone, with a little help from some of the other members, a sufficient number can easily be obtained. A second way in which the members can assist the matter of advertising, is to communicate with an advertiser whenever they can give him information as to something in his line that they may know of in their vicinity. For instance, a number of bridge firms advertise with us. It is an easy matter whenever you know of a bridge letting in your county or vicinity to drop them a line about it. In a similar manner we can assist the other advertisers very frequently. A single notice of this sort sent to them is sometimes worth many times the price of the advertisement, and I assure you that they appreciate it. With a little thoughtfulness in both of these directions we can easily have the means for a publication second to none of its kind.

Now in regard to the program for our annual meetings. Two years ago at Cleveland, you will remember, we resolved that it would be a good thing to have a synopsis of a portion of the papers at least sent to the members a little time before the annual meeting in order to save time and to make the discussions more valuable. So far, however, this has been a difficult end to attain; in fact, it required about one hundred and fifty letters to secure the promise of the papers that we have on the program this time, and to get a synopsis of any of them has seemed to be

out of the question. The papers for our annual meetings ought to be largely voluntary. The Secretary doesn't know upon what topics you prefer to write, nor can he tell just what year you feel disposed to write a paper; since, or a very common answer is, "not this year but next," when asked to prepare something for the coming meeting. I simply call your attention to these things to show you that the success of the Society does not depend on one or two or three men, but upon a number of you, each doing something; but as you readily see, that something would not need to be very much.

I am reminded of the fact that we have passed through several years of hard times for the average surveyor and civil engineer, and the Society is to be congratulated that it prospers as it does. I trust, however, that we have our gaze higher and that what we have accomplished in the past is only a foreshadowing of what we should do in the future.

With many thanks to the members and officers of the Society for the courtesies received from them, I am Truly yours,

C. A. JUDSON, Secretary.

REPORT OF TREASURER.

Gentlemen—I herewith submit statement of receipts and expenditures of the Society from January 12, 1895, and ending February 21, 1896:

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

RECEIPTS.

Sale of Annual Reports	$ 13 30	
Membership fees	15 00	
Annual dues, '92 and '93	15 00	
" " '94	60 00	
" " '95	265 00	
Advertisements, 15th report	100 00	
" 16th "	20 00	
Cash on hand January 12, 1895	167 76—	$656 06

EXPENDITURES.

Printing 15th Annual Report	$260 00	
Stationery and printing	40 12	
Stenographer, Cincinnati meeting	85 00	
Postage	18 25	
Express, freight and cartage	29 83	
Expense, 16th annual meeting	10 50	
Expense of Trustees	1 50	
Allowance to Secretary, 1894	100 00—	545 20
Balance, cash on hand		$110 86

ADDITIONAL RESOURCES.

From advertisements, uncollected	$133 00	
Annnal dues uncollected, 1895	335 00	
" " " 1894	205 00	
Other dues uncollected	74 00—	$747 00

Respectfully submitted,

C. A. JUDSON, Treasurer.

REPORT OF TRUSTEES.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—The undersigned Trustees of your Society for the year 1895-96 have, in accordance with the constitution, duly examined the books of the Secretary-Treasurer, and take pleasure in reporting the same in first-class condition and the balances correct.

It is the sentiment of this board that this Society is under everlasting obligations to Mr. C. A. Judson for the faithful and competent manner in which he has executed the arduous duties of his office during the past four years, and recommend that a vote of thanks be extended him by the Society.

(Signed.)

J. T. BUCK,
FRANK A. BONE,
E. A. KEMMELER,
JNO. W. ATKINSON,
Trustees.

ADDRESS OF WELCOME.

HON. C. G. M'MILLEN, MAYOR OF DAYTON.

Mr. President and Gentlemen of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—I desire to extend to you my unfeigned thanks for the privilege of thus greeting so representative a body of skillful, clear-headed and admirable men. It is with absolute pleasure that I now address you, for you will recall that I previously met all or most of you at the last annual meeting of the Association at Cincinnati. I presume that you will all remember the animated and significant scenes at the banquet on that memorable occasion. You certainly can't forget the bottles of water that were so much in evidence on that evening. You certainly can't forget the feast of stewed reason and the flow of fricasseed reason that later resulted. It was an ideal occasion in my estimation, and I shall never cease to be grateful to Providence for my participation in it.

Now you are in Dayton, of Dayton, and own Dayton. I herewith turn over to you the golden municipal keys that have access to all that this city holds dear, or interesting, or worthy of inspection. The city is yours, but don't waste it. Just admire it and let it stay where it is, for we need it for the forthcoming centennial.

If you have been through our beautiful city, you have noticed what the engineers have done for Dayton. Our beautiful streets, our good system of sewerage, our drainage throughout the city, a city that is very hard to secure a good drainage system, but we think we are in just as good shape as cities that lie high and dry.

You will find during your stay here that our people are all good natured and willing to show you all the points of interest that you may like to see. We hope that your stay will be one of great benefit to you, and that some of you some day may come here to live with us.

We are in the midst of a census here that will show you an increase of greater proportion than any city in the country in the same length of time. We have a city here that is growing rapidly in manufacturing interests, in much greater proportion than a great many places that are much larger than our city. You will notice that in your visit of a few days that you will be with us. Other cities in our country have been dull while Dayton has been busy.

Gentlemen, I am not a civil engineer, but I propose to join the ranks and engineer you throughout the most thriving metropolis of Ohio. By this I mean that I shall annex my services to the already capable entertainment committee, of which our own esteemed city engineer, Mr. Frank M. Turner, is the head. You will find Frank not only all right, but one of the brightest and best men in our municipal government. Again thanking you, I beg leave to say that you, one and all, are most distinctly welcome.

PRESIDENT'S ANNUAL ADDRESS.

BY F. M. TURNER, DAYTON,

Members of Ohio Society of Surveyors and Civil Engineers:

Gentlemen—Until within two or three months prior to this date I had expected that the pleasant duty of welcoming you to this, the seventeenth annual meeting of our association, would devolve upon another better fitted to the occasion than I, but by the resignation of the President-elect, Mr. Cully, it becomes my pleasant duty to address you briefly on this occasion. It is also my pleasure as a resident of this city to heartily bid you welcome to the Gem City.

It is with a sense of gratification that I assert that the interest in our meetings steadily increase, and I believe that by united effort we can make our organization a power for the advancement of our profession.

The most casual observer cannot fail to notice the great changes in the profession of the Civil Engineer since the organization of this Society seventeen years ago, and the Engineer cannot fail to have a certain amount of pride when he feels that to the members of this Society and of kindred organizations in different parts of the world, has fallen the duty of planning and directing the works which have wrought such a change in the social conditions of the world.

Ours is a work which demands an active brain, a power to plan, with the ability to design as well as direct engineering work. Our business is to design the works by which the great sources of power in nature are directed.

The objects of the Ohio Society of Surveyors and Civil Engineers, as defined by the constitution, are the encouragement of professional improvement and good-fellowship among its members by annual meetings for the presentation and discussion of papers on scientific topics, and such other subjects as may be of interest to its members.

Intercourse between members is perhaps the most impor-

[illegible] In no other way can the standard of a profession be raised so well. The man who works alone, without measuring himself by others, never does his best. The engineer must both measure himself by what others do, and let others measure him. Intercourse between members will do more than anything else to make the work of each engineer the work of the whole profession.

This organization ought to be the means of promoting the mutual interchange of the knowledge we have gained by study, observation and experience. We should be ready to give others the benefits of our experience, since we ourselves are so much indebted for whatever we know to the experience of others who have preceded us. Let each member be ready to contribute as he may have had some experience, or to which he has given may be able in preparing papers on subjects concerning which special study; and also in discussing such papers when they are presented, for the paper that brings out the fullest discussion is the most useful to the Society. They are intended to bring out discussions, to compare different views, and in this way to give the knowledge of the profession to all. I venture to say that those who are most ready to contribute to the interest of and success of the Society in the ways indicated, will be the ones who will receive from it the largest benefits.

It is the duty of our Society to elevate the profession of its members to the very highest rank. The engineers of this country never have secured for themselves any fair recognition, either as a class or profession, due largely to a lack of organization.

There will be a bill reported to the Society during the meeting by the Committee on Legislation, regulating the practice of surveying in Ohio, which bill, I believe, should receive the support of every member of the Society, and should become a law, as at the present time the title of civil engineer or surveyor is insignificant.

Any person, regardless of qualifications, can affix the title to his signature if he so desires. He can even hang out his sign, and get and do all the engineering business he can obtain, without possessing the first elementary qualification, and violate no

statute. From this condition we find many persons engaged in the design and construction of work who are not qualified to do so, and to which are due a large number of accidents, which are daily occurring.

There seems to be no good reason why a statute should not be framed, of a general character, applicable to all surveyors and engineers who propose hereafter to practice in this State, requiring them to give evidence of their attainments and fitness, and to obtain a license before undertaking to practice.

In conclusion, I beg to call your attention to the very instructive program of papers to be read during the meeting, and I hope that a free and full discussion will follow each paper, for by this means members will add to the interest of the proceedings and evidence their desire to make the meeting a success.

Thanking you for the kind attention you have given me, I now invite your consideration of the further business of the session.

IMPROVEMENT AT STREET INTERSECTIONS.

BY H. W. M'DONALD, C. E.

This might be properly termed an age of street improvement. The change has been so pronounced that a person returning to his native city after an absence of a few years scarcely knows whether he is at home or not. As a looker-on, I venture to "make a few remarks" relative to the work at street intersections. It is here that we are confronted with cross-walks, conduits, gutter-crossings, catch-basins, stench plates, etc., and where, more than at any other point, the improvement effects the interests and attracts the attention of the general public.

The average citizen, nowadays, is not content with durability alone, but expects sanitary regulation, safety, convenience and artistic appearance added, without additional cost. The consummation of this work devolves upon the City Engineer whose instrument is supposed to enable him to surmount every difficulty—(if not, what are instruments good for?) in order to carry out these additional requirements it is necessary to vary "some" from former methods, and a question whether there is not room for improvement in "those of the present.'

We submit, for the consideration of Engineers, the propriety of abandoning the location of sewer-inlets or catch-basins at curb intersections or street corners, as a rule, and placing them at or near the extension of lot lines on each street, as indicated in our sketch.

We do not claim to have originated the idea, but are satisfied that there is no patent on it, and that its adoption would be a decided improvement for the following reasons:

It would admit of a continuous pavement, on sidewalk grade, across the streets; afford plain-sailing and plenty of leeway for pedestrians and vehicles; dispense with the objectionable gutter, gutter-abutments and crossing-plates, as well as the cost of

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[For illustration of street intersections see advertisement of H. W. McDonald & Co.]

their construction and maintenance, while there would be no sliding off of cross-walks or stepping-down-into-gutters to contend with.

The absence of deep gutters and depressed pavement at street corners would not only add to the safety and convenience of the traveling public, but to the general appearance of the work as well.

If "well-holes" or cess-pools (otherwise called catch-basins) continue to be considered "necessary evils," it would remove them, to some extent, from the line of travel, which certainly would be a move in the right direction, while it would afford additional and ample facilities for conducting surface water into the sewers.

The number of inlets being duplicated, their size and consequent cost would be materially lessened, so that with gutter abutments, crossing-plates and expensive foundations dispensed with, the improvement could be made without additional cost.

The necessity for constructing "large," public cess-pools, with stench-plates or traps (to prevent odors from getting down into the sewers), is being questioned in many cities, and indications point to radical changes.

It would be well, perhaps, before classing these—depositories—among the sanitary improvements of a city, to procure "exaggeration licenses," in order to protect ourselves from the indignities of property owners who do not read up sanitary matters.

The original cost of these cess-pools, although much more than that of practical inlets, does not end the matter by any means. It requires fully ten per cent. of that amount, annually, to bale out and cart away the stagnated contents which Dame Nature would take care of gratuitously, if given half a chance.

The argument (?) advanced in their favor is that "they are 'necessary' in order to intercept the mud, sand and silt which otherwise would be washed into the sewers." Twenty-five years' observation convinces us that "catch-basins" do not intercept one per cent. of the mud, sand or "silt" conducted into them, and

that sewers constructed without them are in equally as good condition.

To demonstrate the truth of this statement, it would be a perfectly safe experiment (odors excepted) to have all the catch-basins, on any given line of sewer, cleaned out just before a rain storm, and the aggregation scattered in the street gutters. One of two things would soon be apparent—there would be more "aggregation" in the "catch-basins" or sewer—or both—after the storm, or the "silt" argument wouldn't hold together. As an illustration of what might be expected, we can refer you to the testimony of hundreds of persons who witnessed a much more aggravated case in the shape of a street plowed up loose from curb to curb, when the city was visited with a regular down-pour of rain, converting the street into a muddy river. In this case, instead of "catch-basins," there were sewer inlets connected with nine-inch P. traps all along the line, and shortly after the storm, to the astonishment of all, nothing but clean water was found in the traps!

The secret lies in the fact that mud never floats until it is converted into muddy water, and when so converted it moves with more alacrity in a smooth sewer, assisted by the power behind it, than in the ordinary street gutter. The same principle applies to sand; if it is "moved" by the action of water in the gutter it cannot "halt" when in the sewer, while "silt" is manufactured only in "stagnant water," and consequently has "no business" or abiding place in a properly constructed sewer system.

If tradition, however, continues to govern, and "catch-basins" remains to "plague man-kind," why not construct the "man-hole" large enough and "deep enough" for the purpose, and have "but one," instead of two or more depositaries at each street intersection? It could be made "deep enough" to hold the aggregated contents of "all" the "catch-basins," and with a fall of ten or twenty feet to the hundred, there would be no reason why "dirty water" shouldn't get through the pipes leading to it. This arrangement would not only lessen the expense, but place the "catch basin" where it would be less objectionable during its periodical renovation, and where, in time, some one "might" suggest the propriety of cleaning it out and "filling it up with brick

and cement," so as to exactly conform with the bottom of the sewer.

Some ten years ago the "sewer inlet" was introduced as a substitute for the "catch-basin" and a short description of the improvement may not be out of place in this connection.

The original patterns were a somewhat modified form of the "catch-basin" cover, having a lower plate reduced to connect with 9, 10 or 12-inch sewer pipe, heavy flanges to rest upon a brick foundation, and man-hole lids varying from 18 to 24 inches in diameter. After being tested and rendering satisfaction, various devices were introduced throughout the country, all retaining the aforesaid flanges and man-hole lids, by way of imitation. The idea recently occurred to the originator of the inlet that it would be a very difficult matter for a man to get down into a 9, 10 or 12-inch sewer pipe, and that smaller or hand-hole lids would answer every purpose. Looking at the matter in this light, it was plain that the form, weight and clumsy appearance of the original inlet could be changed so as to not only improve its appearance, but to dispense entirely with the heavy flanges and man-hole lids, as well as the expensive foundation necessary to sustain the original casting. He, therefore, proceeded to make new patterns accordingly, and to add other features to which your attention is invited.

The inlet, as now improved, occupies "none" of the roadway, and not more than "a square foot" of surface inside the curb-line; has the necessary capacity and is supplied with a removable grate, while the front is made of any desired radius. Its shape, or form, is such as to obviate the necessity and expense of "masonry for a foundation," and permits the contractor to set the inlet in connection with the curb (thus often avoiding vexatious delays), while the small amount of space occupied inside the curb leaves valuable room for basement purposes or for pipe lines. This matter of "space" occupied by catch-basins or inlets may not be considered essential in some cities, while it is regulated by ordinance and enforced in others, to the extent of constructing a portion of the catch-basin in the roadway.

When constructing sewers in advance of permanent street

improvement the engineer is expected to provide the necessary surface water inlets without interfering with existing gutter grades, and it often is the case when trying to make them conform, to place them below established grades only to be torn up and remodeled in the future. To overcome this difficulty the improved inlet is provided with an "adjustable face plate" which is moved up or down in a groove to conform to any depth of gutter, varying from six to fifteen inches; this makes it possible to set the inlet in connection with the curb to line and grade and afterward vary the depth of waterway to conform to any required gutter grade, without interfering with the curb. It also provides a more finished edge, or backing, for paving material, enabling the contractor to make a finished improvement with less labor than would otherwise be done, and is convenient when repairing or remodeling improved streets having gutters of various depths.

Where gutters are of uniform depth, the same style of inlet, with a "fixed" instead of an adjustable face-plate is recommended for general use in connection with street paving.

Commonplace things, like the sewer inlet or catch-basin are apt to be considered of minor importance, while they should be recognized as among the necessary adjuncts of street improvement and receive the same marked attention. Where this is neglected there is always something left undone, which should have been done, and the public are sure to find it out.

Now, while we do not claim to have presented anything entirely new, we have made the drawing, as you see it here, representing the street intersection with sewer inlets located, as "we think they should be," and refer you to another drawing representing "the original inlet," as set upon the street corner. We have given you our reasons for preferring the former, and should be pleased to have an expression of opinion as to which method is the most practical.

DISCUSSION.

J. B. Strawn—I feel that there are some questions in connection with that paper that ought not be passed over. I feel that there is something right there that is not only an everyday thing for us to consider, but often many, many times a day. Looking at the bad arrangements we often find for street intersections and street crossings, it does seem to me that the plan before us has decided advantages. One is especially in the sidewalks running up to the top of the curb. You haven't there a place to step down. You haven't an unpleasant place that will form an unpleasant passage from the sidewalk to the crossing. That is certainly a thing that ladies will appreciate. I am sorry that more of them are not in existence, and if we can do anything in our Society to bring about that happy result, to overcome a thing that is now being very much bemoaned in our city, and probably is in many other parts of this country, we certainly ought to do something in that direction. I can see very decided merit in the plan before us, and in getting those inlets away from the crossings is certainly a great advantage. Another thing is to keep clean crossings, instead of having the low places for collecting mud and water, which is always objectionable at crossings.

Mr. F. M. Lillie—We have in our city a very similar arrangement to that, and about the only difference we make, is this: In the one place we built a regular full-sized catch basin. In the other place we just built a little brick fall—say about two feet square by two feet deep, just enough to let the water fall in, and run a sewer pipe from that inlet to the main catch-basin. It is very similar to Mr. McDonald's, only worked out in a little different manner. They have given excellent satisfaction, in fact I don't think they would have them in any other way. now.

Mr. C. W. Brown—Do you bring your street level to the top of the curb?

Mr. Lillie—We bring ours to about three inches from the top of the curb.

Mr. Brown—Do you notice any trouble in that way?

Mr. Lillie—No, sir.

Mr. White—I would like to ask if it is not more difficult to keep that section drained off which rests so nearly level.

Mr. F. M. Davisson—To drain the water from that section? I do not see why there should be any trouble about that, because from the inlet there, sloping towards the center of the street, it would work the surface each way, and the natural inclination would be for the water to go towards that inlet.

Mr. J. L. Gilpatrick—I would like to know the difference in the expense of one of the old catch-basins and these side basins. What is the relative expense, compared to the one shown?

Mr. McDonald—The two catch-basins being so much less in weight require no extra foundations or substantial arrangement, as is the case with the old style corner basin, in order to prevent settlement. These require nothing of the kind. The curbing makes all the necessary foundation the inlet needs, consequently it would be much cheaper than the old style, saving the work of building catch-basins and sewer inlets of that kind; and, there being a deep gutter in most cities, they put in gutter abutments, and in addition to that gutter plates. I notice a great many of them in this city—iron enough around the corners to make a dozen inlets. That would all be disposed of, and the curb supporting the inlets makes it possible to make this improvement fully as cheap.

Mr. C. A. Judson—In view of the fact that the old style basin has been used so generally, I would like to ask if any argument occurs to any of you why it should not be used. I never really studied the question very much. In the eight years of my experience as city engineer, I used the old style basins, because that is the one I found my predecessors had used, and in fact is about the only one I knew of. They were using them in Toledo and Cleveland, adjacent to our place, and I kept on using them. But, since Mr. McDonald has introduced his catch-basin, I have been at a loss to give any really good reason for the old style basin. Of course the theory is that it will catch the sand and dirt that washes out of the gutter, and it is built large enough to hold that dirt, and, as he said, the dirt could be carted away to some other place. Now, it occurs to me, is there any benefit

in stopping that dirt? Of course, if the sewer can carry it away just as well as not without any injury to the sewer at all, what is the object in carting it away? I do not remember of ever having any trouble with open inlets. Since they have put in an improved inlet in the last few years, I do not remember that we have had any stoppage of sewers in the city as a result of open inlets. As I said, the question occurs to me whether there is any argument in favor of the old style after all.

Mr. Gilpatrick—The objection to that style has arisen from the imperfections in the construction of these old sewers. I have in mind a place at home where the water comes down a short hill, perhaps running down in the course of forty rods 125 feet. Then it strikes off of the hill into the sewer, but before going into the sewer the water passes over or along a level; then, after passing perhaps 100 feet, it strikes down a change of grade, where the grade is perhaps not more than one-fourth as great as in that first 100 feet, and then goes on again down another pitch, and that imperfectly constructed sewer did at some times fill up.

Mr. Strawn—If we had sewers constructed as an old engineer told me of one that he had examined—when he came to examine it, the outlet of the sewer was about four feet higher than the inlet. By that plan the sewer would have a pretty good chance of filling up. And we see a great deal of that kind of engineering in work that was done many years ago—not since the Ohio Society was started. Now, the theory seems to me to be that catch-basins are absolutely absurd when looked at from a sanitary point of view. It is a place to catch filth, it is a place for filth to collect and be decomposed. Now, the writer of that article I think gave us a very excellent illustration of the absolute want of any good ground for the catch-basin. In case where a street was ploughed up and a whole river of dirty water that would fill a hundred catch-basins went into the sewer and out as well. Now, I examined some catch-basins not so very long ago where the catch-basin filled up full the very first shower that came, and it was not a very big shower either. That was cleaned out and it absolutely filled up tho next rain. Now if you will clean it out before decomposition sets in, you will have a fairly good sanitary catch-

basin. I can see no possible use for those old catch-basins, except to give a lot of fellows work, who do not have it and must of necessity have employment. It looks to me like a simple way of giving a lot of men employment who do not have much work. I can see no good of putting in these old catch-basins.

Mr. Gilpatrick—I hope the Society will not be deprived of the remarks of the President, so far as the City of Dayton is concerned, simply because he is in the chair.

President Turner—When I assumed the office of City Engineer here about six years ago, they were using the old style basin, but they became such a nuisance that we have abandoned them, and now use them without the basin. In fact, the Board of Health got after us several times and compelled us to quit using them.

Question—What are the connections?

Mr. Turner—We have been using the straight ones.

Question—Is there no trap?

Mr. Turner—No, sir. We use the separate system here. There is no true sewage in the storm water sewers.

Question—Do you see any objection to such a corner as that (pointing to a sketch of new system), as compared to the other, and do you use anything of that sort in Dayton?

Mr. Turner—We use corners with two catch-basins, but do not place paving level with curbing. We raise the paving so as to make a three or four-inch gutter around the curves. I do not favor making the paving level with curbing, as that would make the surface of the street almost level, and you would have trouble in getting the water off, also people in turning the corners would drive over the sidewalk.

PORTLAND CEMENT-LIME MORTAR.

BY S. B. NEWBERRY, SANDUSKY.

Mr. President and Members of the Ohio Society of Surveyors aud Civil Engineers:

I have decided to speak for a few minutes tonight on the subject of Portland Cement and lime for mortar for brick in masonry. This to me is quite an interesting subject, and a good deal of interesting work has been done on it. I will ask your patience for a few moments while I go into this very briefly:

Mortar is a plastic mixture of sand with lime or cement, used for joining brick or stone or for plastering walls or ceilings.

Three different kinds of mortar are in common use for these purposes. These are:

Lime mortar.

Natural cement mortar.

Portland cement mortar.

Each of these is suitable for certain purposes, and each has its decided drawbacks.

Lime mortar hardens chiefly by drying out, and the hardening is extremely slow and imperfect. It has been found that in mortar over 500 years old, the conversion of the hydrate of lime into carbonate was only partial, most of the lime still remaining in the free state. Owing to its slow and imperfect hardening, and lack of all hydraulic properties, lime mortar is suitable only for the commonest uses.

Natural cement mortar is largely used in building. The variable quality, low tensile strength, and coarse grinding of the common hydraulic cements, make the natural cement mortar a very untrustworthy material, and have led architects and engineers to adopt something better in the construction of important buildings and bridges. The quick-setting qualities of the common cements are also a great cause of inconvenience in their use, making it necessary to mix the mortar in very small quantities at a time.

Portland cement mortar is immensely superior to the preceding in strength, uniformity and permanence. To have good plastic qualities, and work smooth under the trowel it must, however, be rich in cement, containing not more than 2½ parts sand, at most, to 1 part Portland cement. Such a mixture is costly, and is adopted only when the greatest possible strength is required, and economy is a secondary consideration.

Mixtures of Portland cement with 5 or 6 parts sand are abundantly strong for any possible requirement as mortar, and no more costly than natural cement with 2 parts sand. Such mixtures cannot, however, be used for jointing masonry or brickwork, because they are not plastic, and work "short" under the trowel. Poor mixtures of this kind are also very porous, and do not adhere well to brick or stone.

There is a very simple method of correcting these defects in poor mixtures of Portland cement and sand. This is the addition of a suitable proportion of slaked lime, in the form of lime paste. In this way a mortar may be obtained which has all the high qualities of Portland cement, and is, at the same time, plastic, impervious to water, and cheap.

The proportion of lime paste required varies with the amount of sand used. The following standard mixtures have been found satisfactory: (Quantities by measure.)

Portland cement 1, lime paste ½, sand 5.

Portland cement 1, lime paste 1, sand 6 to 7.

Portland cement 1, lime paste 1½, sand 8.

Portland cement 1, lime paste 2, sand 10.

These mixtures are calculated to give in each case the highest density; that is, the cement and lime are so proportioned as to fill the voids of the sand. In ordinary building sand, containing coarse and fine material, the proportion of voids is about one-third of the total volume. Higher proportion of lime than those given would yield weaker mixtures.

As to the strength of Portland cement-lime mortar, it has been clearly proved by careful experiments that while the addition of lime weakens neat cement or rich mixtures of cement and sand, it actually greatly strengthens mixtures containing

more than three parts sand to one of cement. The reason is, evidently, that in these poor mixtures the voids are not filled by the cement, and the lime helps to fill the voids, both in the sand and in the cement itself.

Some of the results obtained in tensile strength tests of Portland cement-lime mortar may be seen in the following table. The figures given represent the average of three briquettes each in the seven and twenty-eight day tests, and one briquette only at one year:

	7 Days.	28 Days.	1 Year.	7 Days Water, 10 Mos. Air.
Portland and Air-Slacked Lime.				
Cement 1, Lime paste ½, Sand 5...	133			394
" 1 " " 1 " 5...	165			432
Portland and Water-Slacked Lime.				
Cement 1, Lime paste ½, Sand 5...	126	180	246	
" 1 " " 1 " 5...	138	183	267	
" 1 " " 1 " 8...	103	165	216	
" 1 " " 1 " 10...	67	92	130	
" 1 " " 1 " 12...	49	63	96	
Louisville Cement and Sand.				
Cement 1, Sand 2.................	43	105	168	
" 1 " 3...	20	66	112	
Portland and Sand.				
Cement 1, Sand 3.................	202	294	375	

In the above tests of Portland cement-lime mortar it will be seen that the proportion of lime used in the mixtures containing 8, 10 and 12 parts sand was too low. As the voids in the sand used amounted to 33 per cent. of the total volume, the combined volumes of cement and lime paste should have been one-third the volume of sand used. It is probable that these proportions, using more lime, would have given higher results in the case of the poorer mixtures. A series of tests on this plan is now in progress, and I hope to have the pleasure of reporting the results at next year's meeting.

Comparing the results obtained with Portland cement-lime mortar and Louisville cement mortar, it will be seen from the table that the mortar, Portland 1, lime 1, sand 8, is superior to

Louisville 1, sand 2; also that the mixture, Portland 1, lime 1, sand 10, is superior to Louisville 1, sand 3.

The comparative cost of these mixtures may be easily calculated, if the cost of the various ingredients is known. We may take the following figures as a fair average, in this section of the country,

Portland cement (American), in sacks, $2.10 per barrel of 380 pounds, or 3 3-10 cubic feet, 63 cents per cubic foot.

Louisville cement, 70 cents per barrel of 260 pounds, or 3 3-10 cubic feet, 21 cents per cubic foot.

Lime, 50 cents per barrel, corresponding to lime paste at 25 cents per barrel of 3 3-10 cubic feet, 7½ cents per cubic foot.

Sand, 60 cents per yard, 2 2-10 cents per cubic foot.

We may now calculate as follows:

Louisville.			**Portland.**			**Portland.**		
Cement 1, Sand 2.			Cement 1, Lime ½, Sand 5.			Cement 1, Lime 1, Sand 8.		
1	cu. ft. cement,	.21	1	cu. ft. cement,	.63	1	cu. ft. cement,	.63
2	" sand,	.044	½	" lime paste,	.04	1	" lime paste,	.075
—		——	5	" sand,	.11	8	" sand,	.175
2⅓	"	.254	—		——	—		——
11 cts. per cubic foot.			5½	"	.78	8	"	.880
			$14\frac{2}{10}$ cts. per cubic foot.			11 cts. per cubic foot.		

It thus appears that good Portland cement-lime mortar is greatly superior to Louisville mortar in strength, and is no more expensive.

The method of mixing cement-lime mortar, as generally recommended, consists in mixing the lime paste with the necessary water, and adding the dry mixture of cement and sand. Another method, which has the advantage of simplicity and saves considerable labor, is simply to use "milk of lime" instead of water for mixing with the cement and sand. This makes the proportion of lime used, however, rather uncertain. The water required to make a plastic mortar with poor mixtures is about 25 per cent. of the volume of cement and sand used. Assuming ordinary milk of lime to consist of one part lime paste and two parts water, the use of this milk of lime for mixing would give about the following proportions:

Cement 1, lime paste $\frac{1}{2}$, sand 5.

Cement 1, lime paste $\frac{3}{4}$, sand 8.

Cement 1, lime paste 1, sand 10.

In the mixtures with eight or ten of sand it would be better to use more lime, as already explained. However, this method of mixing has the great advantage of preventing the introduction of coarse particles of unslaked lime, which by subsequent slaking might greatly damage the work.

One barrel of Portland cement is sufficient to lay 2,000 brick with mortar 1 to $\frac{1}{2}$ to 5, or 3,000 brick with mortar 1 to 1 to 8.

The advantages which Portland cement-lime mortar possesses are, rapidity of hardening, great strength and permanence, extraordinary adhesion to brick or stone, and impermeability by water.

The question of adhesion of Portland cement-lime mortar to brick was experimented on some years ago by Dykerhoff. He found that in poor mixtures of cement and sand the adhesion was increased as much as five times by the addition of a small proportion of lime paste. In Dykerhoff's experiments, bricks were laid crosswise on each other and joined by mortar of different kinds. The surface joined measured 22.3 square inches. The weight required to pull these bricks apart, after three weeks' hardening in air, was 186 pounds with a mortar of 1 to $\frac{1}{2}$ to 7, a number almost exactly equal to that obtained with 1 cement and 3 sand, without lime.

The subject of the permeability by water of various mortars was also investigated by Dykerhoff with discs three-fifths of an inch in thickness. After seven days' hardening, the following results were obtained:

Portland cement 1, sand 1, slightly permeable.

Natural cement 1, sand 1, very permeable.

Portland cement 1, lime $\frac{1}{2}$, sand 2, impermeable, even after long test.

Portland cement 1, lime 1, sand 3, impermeable, even after long test.

Portland cement 1, lime 2, sand 6, impermeable, even after long test.

As to the practical results which have been obtained with Portland cement-lime mortar, the writer would state that this material has been used in a number of important buildings in Cleveland and other cities during the past three years, with very satisfactory results; also that the large brick sewer, Huntington, Ind., completed a year ago, was built with Sandusky Portland cement-lime mortar, 1 to ½ to 5, the work requiring over 3,000 barrels of Portland cement.

Probably one of the largest granite men in St. Louis, Mr. Bruner, told me that he began to mix sand with Portland cement twelve years ago, in setting tiles, and that in spite of all he could do he could not get floor tiles to stick with Portland cement and sand, no matter how much cement he used, but as soon as he used a little slaked lime with it, the adhesion was good and he had no further trouble. In setting tiles he has always used lime with the cement.

I would like to mention one thing that is of practical interest. Some parties at Sandusky, not connected with the Sandusky Portland Cement Company, which I represent, have the material with which to make a snow-white Portland cement, and they are about to begin to erect a small factory for the purpose of manufacturing it. The material is nothing but lime and clay, but absolutely free from iron. It does not contain one-tenth of one per cent. The result is that it is very light in color, and the cement when screened is a white powder. From a number of tests it is found equal if not superior to Portland cement.

The color of the ordinary Portland cement is due to two or three per cent. of oxide of iron. The experiments that I have made show that iron does not enter at all into the hydraulic properties of cement and is better left out, that is, Portland cement used in setting white stone, for the reason that it will not stain the stone. I have been told by architects that it is largely used in St. Louis and Chicago, that the color will spread through the stone to a distance of eighteen inches and will stain the stone just like iron.

Considerable quantities of another cement are being imported into this country for the purpose of setting white stone. It is something like that white Portland cement, and is mixed with one and one-half parts of white sand, such as is used for glassmaking. The result is a white surface. You can see a difference between the two. It is expected that that material will be used for artificial stone for cemetery work. You can see in cemetery stone a great deal of white cement used. It is gray and not attractive in appearance. We have made experiments with this with white crushed marble—marble chips just crushed up. It imitates actual marble admirably.

DISCUSSION.

Mr. J. B. Weddal—I would like to ask what the experience has been in the mixture of lake sand with Portland cement, as to getting it to work freely under the trowel. My experience has not been satisfactory. It does not seem to mix—the cement and sand and water together. Now, I do not know whether I was right in it or whether I had the right materials to work with, or what was the matter, but it did not give me satisfaction. I do not like to give it up because I feel that we ought.to get a mortar out of these ingredients and get a good one. I judge that the trouble is using lake sand and cement for the mortar. It has not the plasticity. If you make it as wet as you have to handle it, the cement and sand will wash apart. They do not adhere. Of course the character of the sand may have a great deal to do with that.

Mr. Strawn—I think I can explain Mr. Weddal's objection. If he had taken a microscope and put some of that sand under the microscope, he would see that the lake sand was nothing but a lot of pebbles or marbles, with no angles to it at all. Whereas, if he would take other sand and put that under the same glass he will find it in little cubes, with sharp angels to it.

I had an experience exactly like that. Sand that I thought was the finest sand I ever saw, was nothing more than little round marbles. It is the quality of the sand. The real properties of retaining bond in the sand to make good mortar have been worn

off with the constant rolling back and forth of the waves, constantly wearing it away to nothing but little marbles. Take some of the lake sand that has been adopted by engineers and simply put it under a microscope, and it will be very easily seen whether it is good sand or not. You take lake sand and roll it in your hand and it is as smooth as flaxseed.

Mr. Weddal—This last has not always been my experience with making mortar out of lake sand. I have succeeded in getting some mortar that worked very nicely.

Mr. Strawn—There is a difference in lake sand, some of it being subject to the action of the water and some of it, being in pockets, being free from it.

I want to get all the opinions on this subject that I can. I may ask some questions that may not exactly be in order. I would like to ask the professor one or two questions in reference to the product of Portland cement. Last summer I specified a cement equal in quality to the Sandusky, and it brought up some discussion in reference to another brand, and we had some little discussion about it on the part of the dealers, some feeling that that was not the very best, and in that discussion several things were brought out that caused me to think about this product of yours—not the Sandusky manufacture. That was this. I cannot give you the authority, but I want to ask you the question whether there enters into its manufacture a certain amount or proportion of lime that is detrimental. I ask this for information, because I want to know.

Mr. Newberry—I cannot readily answer that question, because all cements are composed of about three-fourths of lime and one-fourth of clay.

Mr. Strawn—When it comes to be incorporated with sand, that is detrimental.

Mr. Newberry—There should not be, and I know the Sandusky Cement Company has never sent out any cement that had not passed through the boiling test for free lime. Free lime, if it is present, is the result of defective manufacture. All cements have to contain 2-3 lime, but that lime must be in combination. It must not be free. If it is free, it is because it is imperfectly

prepared. There should not be any free lime in any good Portland cement. I suppose the cement could carry two or three per cent. without being detrimental under certain circumstances. Mix it with two or three per cent. of white lime and put it in mortar and it will swell up, showing the effect that quick lime has on it.

Mr. Strawn—Where you use your mixture as you have it there, what result will you get where the work is all made equal as to its setting qualities?

Mr. Newberry—That is a good question and one that I think I ought to be pretty cautious about answering, because I do not know that anybody could answer that question. It has been claimed that Portland cement lime mortar containing large amounts of lime did stand water well, but it does not stand moving water. I have seen that statement. If I were going to put cement work under water I should not put lime in it. These briquettes were kept a year in water.

Question—How about the Portland cement-lime mortar for underground foundations?

Mr. Newberry—I cannot give any positive answer in regard to underground foundations.

Mr. Strawn—Is it advisable to attempt to mix, say one to one and ten or one to one and twelve, that is by men who usually do the ordinary class of masonry? I would like to ask whether it is not a risk to attempt such a proportion as that.

Mr. Newberry—I do not see why there should be any difficulty with it. If the cement and sand are mixed dry to begin with, and then lime paste mixed with it and the sand shoveled right in. It looks like a very little cement spread out very thin, but when you come to try it, it makes a great deal.

Mr. Strawn—It is all right if you can get it done, but does not the average man neglect to do it?

Mr. Newberry—I do not see why he should. Where it is a question of mixing a good mortar, it can be watched very closely. We make concretes of cement and sand, one to fifteen making most excellent concretes.

There certainly ought to be no difficulty in mixing one part

of cement and one part of sand. As soon as it shows a uniform color, it is well mixed. If this is mixed with the lime and paste it is bound to be a good mixture.

Mr. Strawn—I must confess that my experience has been against your theory. I used more cement than was really necessary.

Mr. Gilpatrick—Do you not find also a difficulty in mixing cement and sand, in getting the proper proportion?

Mr. Newberry—If you get in too much cement, then it spoils it that way. You can overdo the compound by putting in too much cement, but the error is apt to be the other way, especially if it is done by contractors.

Mr. Gilpatrick—They are generally disposed to put in too much sand and too little cement.

Mr. Newberry—I think I have built probably eight brick buildings and as many brick stables, in which I have used cement with lime mortar. I found this to be probably one of the most valuable things that has ever occurred in my experience in building. If you get a nice clean joint in brick work it never washes out and will stand for ages, whereas with lime mortar you very often find that it washes out and in fifteen or twenty or thirty years you have a very unsatisfactory looking wall. I do not like to say with just how little cement we can get along with. Contractors are so conscientious about making it strong with sand, that if you allow one part of cement and twelve of sand, to make sure, they put in one part of cement and twenty-four of sand.

Mr. Strawn—I considered it a very serious case that came up within the last year, where I was very anxious to get an excellent foundation. It was on very dangerous ground. I left instructions for putting in concrete. I went away and got back to my work on Monday evening. I found that a good portion of the concrete was down. It looked to me to be very poor indeed. I made inquiry and they said they had followed my instructions and the specifications. I complained about it being too rich with sand, and the result was that I had it all taken out. I could not detect a particle of cement in it. I had them

make a new mixture and put in the required amount of cement, and that hardened up as hard as you could ask any concrete to harden. But I would not want to go lower than that figure—eight of sand and one of cement—in any work. I do not care how good the cement may be, the finer the better, when you get below eight you are below the danger line. I have samples of concrete made with one part of cement and one sand, but I would not want to depend on it. I took up a piece of concrete of the right mixture and it broke a good solid brick all to pieces without phasing the sample of concrete. That was made with a great deal of care. But you won't get the ordinary workman to take the necessary care to get the work in such shape that will justify you in putting that small amount of cement in it. I do not think it would be advisable. I do not think it would be to the interest of cement makers to advise them. They can get better results by putting in a little more cement. I do not think there is any danger of error in that. I would sooner put in six parts of cement than nine. I am a very ardent admirer of Portland cement in masonry, and work that I have had for a number of years, I have felt that Portland cement, after it was done, was decidedly the most satisfactory. This white Portland cement that has been developed—if that can be produced in quantities at a price not too dear—will be one of the most desirable factors to add to our mortar, for putting up large brick buildings, where you want to have a nice joint. I feel quite sanguine over that part of it. The samples we have here show the results that may be obtained from such cement. As to putting it in arch work, it will have its place and will be much more durable than plaster.

Mr. F. M. Davisson—I remember about ten years ago that I put white lime cement in our stables at home, but the horses and cattle dug it up and we concluded that we would fill it up with Black Diamond cement. We made a good mixture of Black Diamond cement and used two parts of sand and one of cement. It lasted about a year. The next year we went to work and filled it in with about four inches and put it in our cow stables. We only used two parts of sand and one of Port-

land cement. We have also used it in our horse stables. We put it about two inches deep from the top of the Black Diamond cement. Horses have stood on some parts of that for as much as six years—stood on it with sharp shoes and it is just as solid today as the day it was put in.

Mr. Judson—About what are the different ingredients and about what are the proportions for good Portland cement?

Mr. Newberry—I would say that Portland cement is made by mixing together carbonate of lime and clay in proper proportions, burning the mixture at white heat and grinding the result into powder. These proportions should be such that the resulting cement will be about 60 2-3 per cent. of lime. I may say that the proportions of the mixture that will give that result will be about 75 per cent. carbonate of lime and 25 per cent. of clay. These are the only materials that enter into the present Portland cement.

The same thing is true of the natural cements. But these are made of a limestone that already contains clay. If it contains just the right amount of clay for it, the cement will be all right. But a limestone containing too little clay would be useless for any kind of cement. Now, if it will not bear a white heat it contains too much clay. It will not bear as much heat as Portland cement will bear. The result that comes out is soft and can be crushed in the hand and is very easily ground up.

Question—Do you keep up a continual analysis of the clays and lime that you use to manufacture cement, in order to maintain just a certain per cent. of each, so that no mixture will turn out incorrect?

Mr. Newberry—We have to hold the composition of the raw materials to within one per cent. in order to get a good result. Say it is seventy-one per cent. of carbonate of lime. Now, if it is seventy-two per cent. it would contain too much lime, and if it fell as low as seventy per cent. it would show in the tests. Suppose that the limes are seventy per cent. on one end and seventy-two on the other. That is determined every hour. No material is allowed to go out until it is correct.

Mr. Davisson—I would like to ascertain the cause of cement

mortar swelling after it has been in place for some time. What causes it to swell or expand?

Mr. Newberry—It is caused by the presence of free lime, and results from careless manufacturing.

Mr. Davisson—That difficulty does not apply only to Portland cement, as we find it in the natural cements.

Mr. Newberry—It is found in bad Portland cement, and there was a great deal of that cement manufactured a few years ago in this country.

Mr. Davisson—Does the best quality of Portland cement that is manufactured now have this expanding property?

Mr. Newberry—No good Portland cement has that quality in the slightest degree.

Mr. Davisson—It is not so perceptible in a small quantity as it is in large surfaces.

Mr. Newberry—The expanding quality has been very marked and very disastrous in some kinds of work. I think that that is the case principally with the cheaper brands, and not with the good cements. It has been found that lime which contains too high a per cent. of lime shows marked expansion, much more than cement which contains the correct proportions.

Mr. Davisson—My attention was called to a very large piece of masonry that was laid up with cement. A very large arch was turned and the masonry was of a very substantial character, and running rather diagonally across it there was a very large crack, in the upper part of it, but the lower part of the work was in perfect shape. It looked very much as if the crack was due to expansion of the cement and the large quantities of cement that was put in that work. The work cost many, many hundreds of thousands of dollars, and yet that work today is split and there can be found no apparent cause. It is very difficult to understand. The work all seemed perfect, and the foundation seems to be as substantial as it was when the work was completed.

Mr. Newberry—I cannot believe it possible that any cement would swell and not entirely lose its strength. When cement

swells it generally softens. It might possibly have been shrinking instead of swelling.

Mr. Strawn—I think I can answer that by some of my own experience. It was in a cellar. It was put in and seemed to be all right for three or four years. Finally it seemed to be swelling up. It got worse and worse until it raised up about four inches. Finally one day I wanted to know what was the matter. I examined it and found there was a hole under there. I put in more than a barrel of grouting under a space there that was not very large. It took hard blows of a sledge to break that crust. Now, there is a case that to me is very interesting. That floor was put in more than twenty-five years ago. Not more than two years ago I had some of it raised up again and it is now hollow under there. It is in places not over an inch thick, yet I can roll heavy barrels over it. There has been a very interesting thing going on in my cellar for twenty-five years. The cellar all around has a drain six inches lower than the foundation. My cellar drain is outside the building.

SOME TESTS OF NATURAL CEMENT.

BY I. C. BREWER, JR., SANDUSKY.

The following tests of natural cement, made at Sandusky, O., in the autumn of 1895, may be interesting, both in showing the variation in the Louisville cements of different brands, and the high results that may be obtained by insisting upon a cement standing a good test or being rejected.

The specification for concrete on the Water street improvement in Sandusky called for one part good hydraulic cement, two parts clean sharp sand, and five of broken stone. The first cement received by the contractors was of four brands, Crown, Mason's Choice, Flag and Anchor.

Of these, the Mason's Choice showed a yellow color, and the Anchor a dark grey. The Flag brand was lightest, being almost white.

The first briquettes were made September 25, 1895, using 40 per cent. of water, which afterward proved too much. Results were as follows after twenty-four hours in air:

Brand.	Breaking Load.	Remarks.
Crown.	4 lb.	Imperfect briquette.
"	40 lb.	
Mason's Choice.	50 lb.	
" "	80 lb.	
Flag.	42 lb.	
"	64 lb.	

It was decided to use no cement that should not show 75 pounds tensile strength in twenty-four hours in air, and 150 pounds in one week. The first tests had been hastily made, and only two briquettes of each kind used. The second set were as follows:

From the above the Crown brand, though showing fairly well in twenty-four hours in water, was rejected, but at the solicitation of the agent for the Louisville cements, another sample was tried; so was also, at the same time, samples of a fresh car of Anchor brand. Results as follows:

Mixed on Saturday, so given forty-eight hours.

Brand	Per cent W.	Time.	Strength.	Average.	
Crown.	31 per cent.	48 hrs. air.	68		
"	37 "	" "	56	62	Condemned.
Anchor.	31 "	" "	102		
	37 "	" "	90	96	
	31 "	" W.	134		
	37 "	" W.	142	138	

The above confirmed the former test of Crown brand, and none was used.

On October ten a fresh shipment of Flag brand came in. Tests were as follows:

Brand	Time.	Strength.	Average.
Flag.	24 hrs. air.	162	
	" "	110	
	" "	156	
	" "	159	146¾
	1 week air.	216	
	1 "	158	187

On October 15, a further shipment of Mason's Choice arrived. Following results:

Brand.	Time.	Strength.	Average.
Mason's Choice.	24 hrs. air.	114	
	" "	134	
	" "	133	
	" "	140	136¼
	1 week air.	236	
	" "	260	248

It will be noted that Mason's Choice gives lower results in twenty-four hours, but better in a week's time. This cement seemed to be slightly more burned than the other. On October 21 a further shipment of Mason's Choice was received:

Brand.	Time.	Strength.	Average.
Mason's Choice.	36 hrs. air.	156	
	" "	180	
	" "	190	
	" "	210	184
	10 days air.	428	
	" "	410	419

DISCUSSION.

Mr. Strawn—There probably is a pretty fair sample of the ordinary cements. It almost makes an engineer feel that he cannot guess where it is going to strike. They are so thoroughly unreliable. I do not want very much to do with cements other than a good brand of Portland cement that can be depended upon. Of the same kind of cement, one sample may show a strength four times as high as another. You do not know but what the next barrel of cement that you get will be even worse than anything you have had. It is a lottery.

Mr. Judson—That is one reason I had in putting it up. It is to show that there is a great deal of difference. It was taken from the same sack. I know that they were made carefully. It seems to be a fault in the method of manufacture or in the cement itself.

Mr. Charles L. Johnson—It is impossible to make two briquettes alike. Two men working on the same batch of cement, in testing will bring out different results.

REPORT OF THE COMMITTEE ON LEGISLATION.

BY E. F. LAYMAN, CHAIRMAN.

(NOTE—The Committee on Legislation presented a draft of a bill relating to the practice of surveying in Ohio, which was referred to a special committee of five, who made a few minor changes in it and reported it back to the Society. It was adopted and a special committee appointed to have it presented to the General Assembly and passed if possible. It was introduced, but did not come to a vote. The bill read as follows:)

A BILL

TO PROVIDE FOR THE EXAMINATION AND LICENSING OF LAND SURVEYORS IN THE STATE OF OHIO.

Section 1. Be it enacted by the General Assembly of the State of Ohio, That the Governor of the state shall appoint, by and with the consent of the senate, four competent land surveyors, citizens of the State of Ohio, who shall compose the State Surveyors Examining Board. Two of said members, as the Governor shall designate, shall hold their office for two years from the first Monday in June, 1896, and the other two members shall hold their office for four years from the first Monday in June, 1896, and all of said members shall continue in office until their successors shall be appointed and qualified, and during the month of January, A. D. 1898, and every two years thereafter the Governor shall appoint, by and with the consent of the senate, two members from among the licensed land surveyors as successors to the two members whose terms expire the following June. The members first appointed shall, by virtue of their appointment, be commissioned as Ohio Land Surveyors without examination or payment of fees. Vacancies in said board shall be filled, in the manner hereinbefore provided, for the unexpired term.

Sec. 2. The State Surveyors Examining Board, shall within ten days after the first Monday of June in each year,

organize by electing one of their number as president and one as secretary and treasurer. Said board shall have power to make such rules for the transaction of business, for the examination of applicants and for prescribing the duties of its officers as it may from time to time deem necessary. The board shall meet at least once each year in the city of Columbus, and at least once each year at such other place in the state as it may designate. Notice of the time and place of each meeting shall be given by the secretary at least ten days prior thereto by mail to each applicant for a license, and also by publication in one daily newspaper printed in the English language and published in the cities of Columbus, Cleveland, Cincinnati and Toledo. Annually, during the ten days preceding the last day of December, the board shall make full report, in writing, giving receipts and disbursements, to the Governor of the state.

Sec. 3. Any person residing in the State of Ohio who has practiced land surveying for a period of five years, or who being a graduate of some engineering school, approved by the board, and has practiced land surveying for a period of three years, shall be entitled to receive a commission as an Ohio land surveyor, without being examined by the board, upon the payment of a fee of ten dollars, and shall be entitled to hold said commission, unless revoked as hereinafter provided, as long as he shall pay to said board, on or before the first Monday in June of each and every year such fee as the board may fix, not exceeding five dollars ($5). Any person who is not qualified as above set forth may receive a commission as an Ohio land surveyor, provided he pass such examination as may be required by the board and pay a fee of ten dollars ($10), and he shall hold his commission, unless revoked as hereinafter provided, as long as he shall pay to said board on or before the first Monday in June of each and every year such fee as the board may direct, not to exceed five dollars. Each commission issued by the board shall authorize the person receiving same to survey land in any county in the state and to perform all acts in relation to the surveying, subdivision and partitioning of land, and to certify the same, which the county surveyor is now authorized to do.

Sec. 4. A certified copy of the names and residence of all persons commissioned by the board shall be filed with the secretary of state who shall make proper record of same.

Sec. 5. The board shall have power to revoke the commission of any Ohio land surveyor, upon satisfactory evidence of his incompetence or misconduct, he having had due opportunity to appear in his own defense, or upon failure to pay the annual fee. Upon such revocation and notice thereof, the Secretary of State, the Secretary of the Board and the recorder of the county in which the member shall reside, shall cancel the same upon their respective records, marking thereon the date of the cancellation.

Sec. 6. Out of the funds collected by the board, it shall first pay all the expenses of carrying out this act, including stationery, postage. clerk hire, traveling expenses in going and returning from meetings, and out of any remaining funds a salary of not more than ten dollars per day to each member for the time actually employed in the business of the commission and in necessary travel to and from the meetings.

Sec. 7. Each person commissioned as an Ohio land surveyor shall, within ten days after receiving his commission, take an oath or affirmation before the clerk of the court of common pleas of the county in which he resides, that he will faithfully and impartially perform the duties of an Ohio land surveyor to the best of his skill and abilities; and said commission must be then at once left for record with the recorder of the county in which said member resides, and a certified copy of said record shall be evidence in all courts of law and equity without producing or accounting for the original commission.

Sec. 8. It shall be unlawful, after the first Monday in October, 1896, for any person to act as principal in the surveying of any land in the State of Ohio, unless he shall have received a commission as an Ohio land surveyor; and it shall also be unlawful, after said date, for any person not holding a commission as an Ohio land surveyor or one whose commission has been revoked, to represent himself as an Ohio land surveyor or to sign any plats, profiles, plans, certificates, descriptions or other documents as

such, and any person violating any of the provisions of this section shall upon conviction thereof, be deemed guilty of a misdemeanor and shall be fined in any sum not exceeding one hundred dollars, together with the costs of prosecution.

Sec. 9. Every Ohio land surveyor shall have the authority to administer the necessary oath or affirmation to his chainmen and flagmen for the faithful performance of their duties and also to administer and certify any oath or affirmation required to be taken by commissioners for the assignment of dower, partition of real estate, or by any commissioner or viewer to mark, locate or relocate any public highway or private road and to take evidence under oath or affirmation administered by him (and to incorporate the same with the survey), of any person regarding the location and identity of any landmark, line or monument.

Sec. 10. Any Ohio land surveyor who may be summoned to testify before any court as to the location, correctness or description of any survey, plat or highway or to give any expert testimony as a surveyor, shall be entitled to demand and receive for his services the sum of five dollars per day for each day he may be required to attend court and mileage at the rate of ten cents per mile from his place of residence to the court house or building in which the court is held; provided, however, that he has not previously agreed with the party summoning him as to his compensation for his services as a witness, and provided also that any Ohio land surveyor summoned to testify as hereinbefore provided may before being sworn demand his fee and mileage and upon the party summoning him refusing to pay the same he may decline to testify and shall be excused by the judge of the court.

Sec. 11. The charges or bill of any Ohio land surveyor shall be held to be money due for labor performed and the same may be made a lien upon the property surveyed as in the manner provided in the Revised Statutes of the State of Ohio for the filing and enforcement of liens.

Sec. 12. All surveys and proceedings had and done by an Ohio land surveyor, under and by virtue of this act, shall be held

and taken to be prima facie correct; and all plats and certificates thereof under the hand of said surveyor, shall be received in evidence in all courts of law and equity in this state.

Sec. 13. All acts or parts of acts inconsistent with the provisions hereof are hereby repealed, and this act shall take effect and be in force from and after the earliest period allowed by law.

REPORT OF THE COMMITTEE ON CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING.

BY F. M. LILLIE, CHAIRMAN.

A full report from this committee would probably mean a review of engineering progress in all these branches. Such a report would require more time than is now at the disposal of your committee, and we have thought best merely to indicate some of the leading lines of industrial progress at the present time.

The subject of deep water ways has of late more and more attracted the attention of the general public as well as engineers, both at home and abroad. France for years has spent large sums on her internal waterways. Much progress is now being made in Germany on these lines, of which the most noticeable is the Kiel Canal lately opened. Glasgow many years ago made herself a seaport by deepening the Clyde, and it is to this largely that she owes her great prosperity. Manchester has lately followed her example, with what success remains to be seen. In Canada the subject of deep water ways is receiving great attention, and the United States is now thoroughly awake to the importance of this subject. Chicago has set the example by building one of the great canals of modern times. Although primarily a sanitary measure, it needs but to be continued to be one of the great ship canals of the age. The next few years can hardly fail to produce great developments in this field.

In the electrical field the extension of street car lines into the country gives a large field for the engineer, but is of scarcely less interest to the student of our social life. We believe this development binding more closely the towns and cities, to be one of great interest, and will be worthy the study of all thoughtful students. Commercially it would seem to tend to make the city more and the town less, but on the other hand, it can hardly fail to extend the limits of the territory in which the city workers

are able to live from their work, thus spreading the city over a large field.

Perhaps there is no field presenting more interesting problems for the engineer than those growing out of the astonishing development of our cities.

It is remarkable to note how similar the conditions and problems are in both the new and the old world. We are apt to look at the growth of our cities as an incident in the settlement of a new country. While this may be true of the exceptional western town, it needs but a glance at the old world to see that the growth of our cities is a condition of modern civilization. From Glasgow and London to Buda-Pesth, and from Naples to Stockholm, the same facts exist. The growth of cities at the expense of the country. Berlin was smaller than New York in 1870 and larger in 1890; Hamburg has outgrown Boston by 100,000 in the last twenty years. Cologne had less population than Cleveland in 1880, and more in 1890. Christiana, Sweden, has three times the population it had thirty years ago. In France the country population is decreasing and the cities growing rapidly. It is the same with us in the older districts. The cities and towns increase, but the rural districts remain stationary or fall off. Many examples might be given of this had we time. If then city life is it to be the lot of a large part of our population, it is for our generation to meet these changed conditions and study well the problems arising from these conditions. And no class of men will have more to do with the material problems of city life than the engineer. The comfort and safety and health of the public will depend upon his work. But if he would attain success in his profession he must be much more than the old-time engineer. He must have somewhat of the artistic element. His bridges must not only be safe to meet the many demands of traffic, they must also be ornaments to the town from an architectural standpoint. His grades and lines must please the eye as well as meet the demands from an engineering standpoint. He should be enough versed in electrical work to at least judge of the feasibility of many projects in this field. But especially in the field of sanitary science there is much that will depend on his work.

It is true that Boards of Health have here a great work to do, but in regard to clear and healthful pavements, in sewerage and water supply, an equal responsibility rests on the engineer. Country life was formerly looked at as the ideal healthful life and city life as tending to shorten life, and the death rate of many cities tended to bear out this opinion. But with the growing population of our cities, it becomes more and more essential that the conditions of city life should be equally healthful at least to those in the country. Much has been done abroad in this respect. In Holland, a country of towns and cities, the present death rate is only 19 per 1,000, but Amsterdam and The Hague have each a death rate below this. In Hamburg the death rate has dropped from 30 to 20 in the last 25 years by its improved water supply and other sanitary reforms. As much might be said for Paris and Rome and many other cities. Typhoid fever is practically stamped out as a fatal disease in Munich, in Berlin, The Hague and Vienna by pure water supply and improved sewerage. Because American cities have felt the pressure of the evils of less, we have been slower to adopt such reforms here, but we believe the day is now at hand when the evils of impure water, unclean and unhealthy pavements and inadequate sewerage and sewerage polluted streams will be no longer tolerated. Massachusetts has already done much. The work of her State Board of Health, which has always had one engineer at least among its members, has a world-wide reputation. Others are now following in her lead. It then becomes the duty of the engineer to carefully study what has been done elsewhere that he may meet the duties of his station as they arise.

DISCUSSION.

Mr. Brown—Mr. Lillie touched on one or two things which were very interesting and very important, especially in regard to sanitary features and other matters, but one that I thought he possibly overlooked was in regard to the waterways. He did not mention in regard to the surveys that are being made for the Ohio ship canal. I might mention just one word in regard to these surveys. I have had the pleasure of the acquaintance of

Captain Chittenden, who has had charge of this work, and have talked with him in regard to it, and I want to simply inform you of one feature of his report, which no doubt will be published, which will be of great value to the sanitary engineers of the state, especially engineers looking after water supplies. He has made a thorough study of the streams of the state in connection with the water supply for the proposed canal. He has gathered up everything he could hear of and worked it up in good shape, condensed it and put it in such shape that it will be of great value to hydraulic engineers. He has just made his report to his board, and I presume it will be published. Be on the lookout for it when it does come out, so that you can secure a copy of the report.

Mr. Judson--There is one thing in regard to the Manchester ship canal, which Mr. Lillie referred to in his paper. What is the fact in regard to it? I understand that it is not a success financially. Am I right about that?

Mr. Lillie—That is my understanding. It does not at the present time appear to be a financial success, but the advocates of ship canals claim that the traffic is increasing all the time, and it will be only a short time before it will pay, and that is why I put it in that questionable way. I do not think that it has paid yet, but it is a question whether it will pay or not.

RANDOM NOTES.

BY H. L. WEBER, RICHMOND, IND.

It has always seemed to me that our profession is both peculiar and fascinating; its mysteries the least understood by the general public, and that we live many years in advance of nine-tenths of our people. That upon our roster are recorded the names of the brightest and best men of our nation. This was so in the past and will be so in the future. We have few drones, simply because the inducements offered this class are very poor, and they are soon left at some P. T. to work out their own destination along some other Tangent.

We point with pride to the many great achievements in engineering and to the engineers, who have won laurels for themselves and honors for our profession; to the "Engineering News," "Engineering Record," "Mining Engineer," "Paving and Municipal Engineering" and the "Engineering Magazine," which have all done such noble work. These periodicals are all works of art, and have done much to further our cause and the general good of our country, and are the peers of any literature of the day. You may think this assertion a broad one; no doubt it is, but why have I not a right to proclaim that "the American Engineer, his works and his journals have done more to make this vast domain what it is—the best country to live in upon the face of the earth—than any other class of people or literature." You find us in advance of civilization, staking out the claims of those who are to follow; you find us in the rear; you find us everywhere, ever persistent in teaching suffering humanity how to live and better their condition. You find us so far ahead of the procession in the "March of Progress" that to read and record the inscription on our banner, "We lead while others follow," requires an astronomical transit and an electrical appliance, which, by the way, are both our own inventions.

Our phenomenal success I attribute to the practicability

of our many schemes, and our energy to carry them into a successful operation.

Don't think that our sailing has been clear and unobstructed. Quite the reverse. We have met resistance at every P. C., but it is hard to keep an engineer below grade.

However, his fate is too often like that of the rooster that

"Flies upon the fence,
His satisfaction is immense,
His self-possession is intense,
His lusty lungs give evidence
That this is so.
Ah, another rooster sees him there,
And hears him crow.
With flapping wings he cleaves the air,
The fence top is too small to share,
And so they fight, and scratch, and tear,
Till down they go."

When the engineer becomes eminent, some jealous politician casts his eye that way, and schemes to down him if he can, and if he just upsets his plans he is content.

Tucked away in the darkest room, and the most secluded spot in a City Hall or Court House, in many instances, you will find the Engineering department, hampered for room, and that most desirable article, light.

Why the Supervising Architect, the City Council and the County Commissioners do not provide suitable rooms, with proper light, safety vault and paraphernalia so the Engineer can properly and promptly execute his work, I have many a time been at a loss to understand, and have come to the conclusion that had an Engineer been employed to supervise the plans, the accommodation and saving to the general public would have balanced many times the extra cost incurred thereby. I have no reason to complain; I am nicely situated, but sympathize with those who are not. I only regret that the services of an engineer are often not asked for, until some one "gets in a hole," and then there is a necessity for an engineer to pull him out.

The old saw runs along the line "that it is much easier to

observe the mote in thy neighbor's eye, than to be convinced that your own optical illusion is caused by a mud-sill," or words to that effect.

The moral is: Never find fault; always make the best of your surroundings; treat your superior, as well as your inferior officers with due courtesy, and give them credit for the good deeds done; it will encourage them to do better.

Take pleasure in devoting the time and attention necessary to explain your plans and specifications even to those who are not supposed to understand all the details fully, but who fully understand that they are to pay for the execution of the work. By so doing, you will make friends, and the people will enjoy your company, and will praise your efforts, instead of shunning you and heaping censure upon you.

My experience teaches me to never cross a bridge until you get one, or get to it anyway. The one to be built on Main street in the "Quaker City" is no exception.

Take things as you find them. If you can't find them, hunt for them. I have become quite accustomed to doing this; so much so, in fact, that my neighbor, the city clerk, comes direct to my office when anything in his department is missing.

Life is what we make it; bright and clear, or like a blue or black print made from a dirty tracing on a cloudy day.

I have brought a few prints of this kind with me, and trust you will enjoy looking at them. We all enjoy looking over each others' work, in search of pointers.

Photography is becoming one of the essentials in the Department of Civil Engineering. Soon we will all have to carry a camera as well as a transit, or a transit with a camera attachment.

It is of especial advantage in municipal and railroad work. In case of wrecks, accidents, fires, etc., where damage suits may be expected, the camera is most valuable. The true condition of affairs may be caught and maintained as it occurred, without relying on the memory of some excited witness, whose vision is liable to be distorted by the glitter of Uncle Sam's standard, whether it be gold or silver.

Also in general work, photography serves admirably not only to illustrate the points, but to give a clearer idea and better understanding of the surroundings to a person not acquainted with them.

Our dry plate system is the most convenient and efficient. The plate is an ordinary square piece of glass, clear and free from bubbles, and with one side covered with a film of gelatine which is saturated with a solution of silver chloride, as the principal agent. This solution is extremely sensitive to the action of light; a chemical change resulting from the contact. Having exposed the plate a sufficient length of time—which is only learned by experience—the next step is to bring forth the image which we have so mysteriously captured, and hold it from further chemical change, to "develop" it. The "Pyro" developer is considered the best for our work, although there are many different solutions which will produce the desired result. The developer should be kept in two solutions:

No. 1 consists of	sodium sulphate	4 parts.
	Pyrogallic acid	1 part.
	Water	16 parts.
Solution No. 2 consists of	sal soda	4 parts.
	Water	16 parts.

To prepare for use, add 75-100 part No. 1, 1 part No. 2, and 8 25-100 parts water.

The final step is to print from the negative. This can be done on regular blue print paper if desired, but the regular photograph paper gives better results and is far more satisfactory.

Take it all together, photography is of great vadue in a professional way, to say nothing of the pleasure of taking the "mugs" of all the criminals for the police department. I could hardly keep house without a camera, and I am sure that I would as soon dispense with my "caligraph," for it doesn't spell right, anyway.

I submit a sample of my plans illustrated by the camera, in this way. This would often assist the contractor in making his bid.

By the way, the contractor is not the worst fellow in the

world, provided the engineer is a good sort of a fellow, with practical ideas. I have always made it a point to make my specifications as full and plain as possible, and to draw my plans the same way, and to put an interpretation on them that would allow an honest contractor "to live and let live," and that a "shark" could not shirk. By so doing, I have had very little trouble, and have secured very good improvements.

I submit to the Society a set of my specifications, and trust you will criticise them so that I can correct my errors, and thereby profit by our meeting. I say "our" I suppose, because I feel that I could not ask for my demit, and I know of nothing in the constitution that requires me to do so, simply because I am a "Hoosier," and from the "Quaker City." Let me tell you something about the "Quaker City," Richmond, Ind. Of course you will say: "Oh, that's like Weber, always puffing up the city in which he lives." I know that's my hobby, and I think an engineer who has no good word to say of his city should move out of it.

We have about 20,000 very live people. If there had not been so many planted in our beautiful cemeteries, we would have had more. But the beauty of these does not attract me, for that's the last place I want to go to. Geographically, we are situated at 39 degrees 51 minutes north latitude, and 84 degrees 54 minutes 15.6 seconds west longitude, and about 1,000 feet above mean tide at Sandy Hook. We are upon the beautiful banks of the White river, with more beautiful banks than river.

We have four railroads on the ground, controlled by the Pennsylvania company, and three more on paper, claimed by many to be under the same control. The roads in operation, are railroads in every sense of the word, and if our street railway system were only under the same control, I am sure that it would be better maintained.

Our Water Works plant is "par excellent," and is only discounted by the water it supplies. Our system is without a superior in the country. The quantity consumed is greater "per capita" than is commonly the case, and the quality. I may safely

say, is unapproachable. This may sound like vain boasting, but here is the analysis, and you can judge for yourselves.

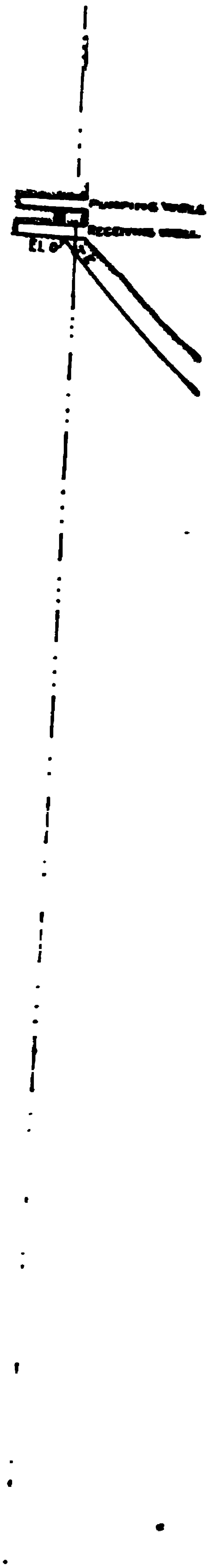
The water is a light bluish color, by transmitted light. It gives no odor of any kind when heated:

Total solids	46.0000	per 100,000 parts.
Nitrogen in nitrates...........	.0012	"
Nitrogen in nitrites............	......	
Ammonia, free and saline......	.0008	"
Albumenoid ammonia	.0006	"
Chlorine	.2829	"
Calcium carbonate	.233	"
Iron	.028	"

Maximum summer temperature of the water is 49 degrees.

Can any of you claim a supply ahead of this in quality? This supply is drawn from a large section of country, which has been noted ever since its settlement for the quality and abundance of its water. Within its boundaries are numerous large springs, which may safely be called enormous. These are located at a distance of from one-fourth of a mile to three miles from the pumping station.

One very interesting feature of the system is the siphon line, which runs from one of the wells to the pump house. This has a length of three miles, or accurately 16,300 feet, and is 16 inches in diameter. It is laid with the ordinary lead joint, but with extra amount of care in the caulking. The ascending arm is 6,000 feet long, leaving 10,300 feet for the descending branch. The supply well is 18 feet in diameter and 13 feet deep. The summit of the siphon is 7 feet above the surface at the well, thus making a lift of 20 feet. The discharge is 92 feet below the summit. When running full, it discharges 3,000,000 gallons daily. It discharges into a large receiving well from which it flows into the pumping well beneath the pumps. A short distance from the supply well is placed a check valve, made of aluminum; above this is a gate valve; at the summit is a 4-inch pipe, which runs up into an air chamber, in which is a 4-inch check valve, horizontal when closed. Above this is a 3-inch overflow discharging on the surface. Near the pump house is a 6-



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inch connection with the line running to the reservoir. This connection is controlled by a gate valve. Further down the siphon is a ¾-inch connection with the gauge in the pump house. Just above the receiving well, is a gate valve. The flow in the siphon is indicated by the gauge in the station. As the air accumulates and the flow weakens, the gauge falls, until the point is reached which notifies the engineer that "priming" is necessary. This is done as follows: The gate valve at the receiving well, marked "E" on the accompanying plan, is closed; the valve "D" connecting with the reservoir is opened; the reservoir pressure fills the siphon to the check valve "A," which prevents backing into the supply well; then the check valve "C" at the summit is forced open, and the water fills the chamber and flows out the discharge pipe. The gauge at the station shows when this is done; then the valve "D," connecting with the reservoir, is closed, and the valve "E," at the receiving well is opened, and the siphon resumes its operation.

This method of priming, you will see, is devoid of expense, making it unnecessary to use the pumps direct for that purpose. Priming is done once a day in times of heavy use, and about twice a week when the use is light. It has run for a week before stopping entirely.

This siphon line was constructed by Mr. Fred. M. Curtis, the very efficient superintendent of the Water Works company, who plainly understands his business, as the working of this siphon, as well as many other things, shows. To him, and to the progressive spirit of the company, is due much credit for the efficiency of our water supply.

We depend wholly on direct pressure for fire protection; maintaining only the hose wagons, with one steamer in reserve, in case of an emergency. We have a continuous pressure of 70 pounds per square inch, and a fire pressure of 110 pounds. The reservoir is 162 feet above the central part of the city. The pumping plant consists of two Holly pumps, one 6 and one 4, making the total capacity 10,000,000 gallons daily. The reservoir capacity is 11,000,000 gallons. We have 40 miles of mains, 238 fire hydrants and 2,000 private taps.

Now, Judson, what do you think of that? Don't say you can discount it with your supply from Sandusky bay. I will not dispute the fact that you have the nicest bathing beach, "Cedar Point," on earth, but I question the purity of your water supply, and doubtless you would do so, if I were to tell you how many times I have bathed at "Cedar Point."

We have the finest Court House in many states, and it isn't haunted, either, except by the troops of cheerful taxpayers marching in to pay their small proportion of the cost, which was only $475,000.

Our main street is the "Old National Road," with the old bridge over Whitewater river still in existence. This bridge was built in 1834 and was considered an engineering wonder in its palmy days.

Our latest bridge is a three-hinge arch, 400-foot span, 65 feet above the water. You will agree with me that a bridge of that kind is not seen every day.

The city engineer's department is frequently called upon to do work not strictly within the domain of engineering. When anything comes up that is too difficult or disagreeable for any other department of the city government, it generally falls to the lot of the engineer. He is supposed to be a person of broad education and universal information; a sort of walking "Encyclopedia Britannica," and "Ready Reckoner," as it were. And often he is called upon to scatter his talents abroad, not for filthy lucre, but for glory, and glory in homeopathic doses at that. Among the many things required of the engineer in our city, is the computation of a time-table for the lighting of street lamps. Just why this should fall to our lot is unknown, unless it is because only in the engineer's office is found sufficient knowledge of "arithmetic" for this purpose. We might use the "Philadelphia" schedule, but although our city is called the "Quaker City," we are not slow enough to follow in the footsteps of Philadelphia. We will have a schedule of our own, even if we cannot afford a private sun and moon as yet. And if the heavenly bodies won't work according to our schedule, so much the worse for them.


OLD NATIONAL BRIDGE RICHMOND, IND
MORRIS & HUNT

Now, just because we have a moonlight schedule, don't imagine that our town is a back number, and that, when the moon fails to shine we stay in bed till the sun rises. Although we don't stay up late nights, we claim to be wide awake in the morning, and "up and coming," no matter what the state of the atmosphere, and we are entirely too progressive to permit "the sun to rule by day and the moon by night." That was all right "in the beginning," but it doesn't work now.

We have an electric light plant second to none, and our streets are illuminated "all night and every night from dusk to dawn," in a manner unexcelled. Our schedule had its birth away back in the "dark ages" before the invention of electric light, and when economy made it necessary to work the moon "for all there was in it," even when full.

The schedule now is reduced in usefulness, until we only have subject to its sway, a few lights in the suburbs and outskirts of the city, where as yet it is inexpedient to locate arc lights.

But the labor of its computation is still the same, and it may not be uninteresting to examine the method of calculation. When we are not too much rushed with work, we compute the movements of the sun and moon for our exact locality, from the elements given in the Nautical Almanac in connection with our latitude and longitude. The length of twilight is also computed in the same way.* When we have not the leisure for such elaborate calculations, the time of the rising and setting can be taken approximately from the common almanac.

There is a first class government astronomical transit in our city, located in the observatory at Earlham college, which, by the way, is an institution of high reputation and higher value, and of which we are justly proud. This transit, the equatorial telescope and the other appliances in the observatory are all the very best, and the observations made with them, and the calculations made therefrom establish our position on the earth's surface very accurately, more accurately, of course, than is necessary for this purpose.

The times of the rising and setting, and the length of twi-

light having been computed, we allow a "factor of safety," as in other engineering work, not to provide for variations in the movements of the heavenly bodies, but to allow for different atmospheric conditions.

Our contract calls for 2,200 hours of light per year. We usually schedule from 2,050 to 2,150 hours, and place the remainder at the disposal of the police department, to be used on special occasions.

We have 1.1 miles brick streets, 5.5 miles macadam, 36 miles graveled and bouldered, 6.1 miles pike, 16 miles unimproved.

We have 17 miles of sewers, combined system, provided with 35 flush tanks, at present, and will soon contract for 2 miles more, to be built immediately. Our sewers discharge into the river. We have sewer grades unexcelled by any city in the country. We put in nothing less than a .5 per cent. grade. We have an outfall of from 20 to 80 feet, so will have no trouble in making water "run down hill."

The "Engle" people have just put up for us a garbage crematory, which is calculated to dispose of all our garbage in a satisfactory manner. It will dispose of 50 cubic yards of garbage, or 25 cubic yards of garbage and 600 gallons of night soil per day of 24 hours. Next year we will tell you how it works.

We manufacture almost everything from a bicycle to a threshing machine.

We have the prettiest natural park that you would ever care to see. It would make the average landscape engineer go wild with delight to pay it a visit.

Our hotel accommodations are the best in several states. The Hotel "Westcott," recently completed, is the admiration of every traveler that comes this way, and cost our Commercial club $170,000.

Now, don't you think that this would be a good place to hold your next meeting, if you can come outside of the great State of Ohio.

If you come as a society, we will welcome you; if you

Day of Month	22	23	24	25	26	27	28	29	30	31
Moons Phase										
Moons time Allow	1.30	1.20	1.10	1.00	.50	.40	.30	.20	.10	.20
Time Moon Rise										7.07
Time Moon Set	Morn	.55	1.59	3.07	4.13	5.15	6.11	6.57	Rise	
Time to Light or E	1.25 L	⊙	.49 L	2.07 L	3.23 L	4.35 L	4.41	4.37		7.27
Twilights ends in Ev	6.02	6.03	6.04	6.06	6.07	6.09	6.11	6.13	6.14	6.15
Time Sun Sets	5.05	5.06	5.07	5.08	5.09	5.11	5.12	5.14	5.15	5.16
Length of Twili	.57	.57	.57	.58	.58	.58	.59	.59	.59	.59
Time Sun Rises	7.19	7.18	7.18	7.17	7.16	7.15	7.14	7.13	7.12	7.11
Twilight begins in	6.22	6.21	6.21	6.19	6.18	6.17	6.15	6.14	6.13	6.12
	E	E	E	E	E	E				

Day of Month	22	23	24	25	26	27	28	29	30	
Moons Phase										
Moons time Allo	.40	.30	.20	.10	.20	.30	.40	.50	1.00	
Time Moon Ris					9.06	9.37	10.04	10.26	10.46	
Time Moon Set	1.45	2.28	3.21	Rise						
Time to Light or = E	1.05 L	1.58	3.01		9.26	10.07	10.44 E	11.16 E	11.46 E	
Twilight Ends in E	9.02	9.02	9.01	9.01	9.01	9.01	L 9.00	L 9.00	L 8.59	
Time Sun Set	7.33	7.33	7.33	7.33	7.34	7.34	7.34	7.34	7.34	
Length of Twil	1.29	1.29	1.29	1.28	1.27	1.27	1.26	1.26	1.25	
Time Sun Rise	4.31	4.31	4.31	4.31	4.32	4.32	4.33	4.33	4.33	
Twilight Begins in	3.02	3.02	3.03	3.03	3.05	3.05	3.07	3.07	3.08	

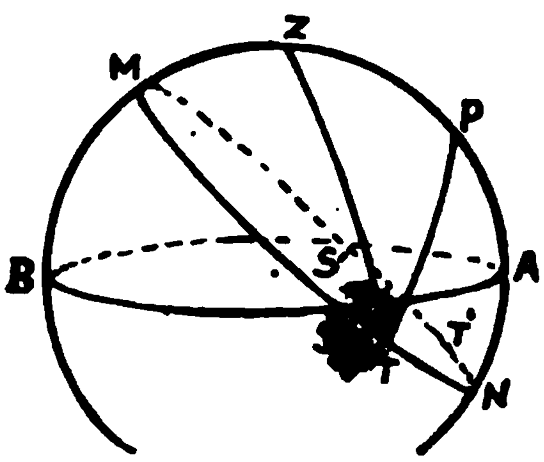
EXTINGUISH = E

LIGHT = L

come as individuals, you will be twice welcomed, and we will take a day off and show you the "Quaker City" in all its glory. Consider the invitation extended to one and all; come when you may, you will find our latch string always out.

METHOD OF COMPUTING TWILIGHT.

Twilight lasts while the sun is not more than 18 degrees below the horizon. Consequently, the problem is how long after sunset or before sunrise does the sun reach a point 18 degrees below the horizon of given place.



Let A S B represent the horizon; Z the zenith; P the pole of the heavens; M S T N the circle of the sun around the pole. Twilight lasts while the sun moves from S to T, and from S^1 to T^1. In the triangle ZPT, we have given the three sides, TZ, the sun's zenith distance, 108 degrees; ZP, the co-latitude of the place, and PT, the sun's polar distance. From this we can compute the sun's hour angle, the angle ZPT. Take for example June 15, 1896.

TZ..........Sun's zenith distance	108°
ZP.. Co-latitude, Richmond, Ind.	50° 9′
PT..Sun's polar distance June 15	64° 38′ 49.5″
Sum of three sides	222° 47′ 49 .5″
Half " " " "	111° 23′ 54.75″ = "S" in formula.

Formula for computing angle ZPT.

$\sin \frac{1}{2} ZPT = \sqrt{\sin (S-ZP) \sin (S-PT) \csc. ZP \csc. PT}.$

log sin (S—ZP)............................	9.942858
log sin (S—PT)............................	9.862363
log csc ZP................................	.114795
log csc PT................................	.043982
2 |	19.963998
	9.981999....sin ½ ZPT.

½ ZPT = 73° 37′

ZPT = 147° 14′ = Sun's hour angle.

147° 14′ ÷ 15 = 9 hours 54 minutes from time of passing meridian.

DISCUSSION.

Mr. Brown—It might be interesting to the members for Mr. Weber, if he has the blue prints of the siphon, to put them up and explain it a little more fully.

Mr. Weber puts up blue prints and explains siphon.

Mr. Davisson—Where is the temperature taken?

Mr. Weber—It was taken in the well. All our water comes direct from the well. We use it out and it fills right up. If anything should happen to the engine or pumps, the pressure comes from the reservoir. We have lots of good water.

(Mr. Weber showed a picture of a spring struck while digging a sewer.)

Mr. Gilpatrick—Are large quantities of your water used in the manufactories of your city?

Mr. Weber—Yes, very much.

Mr. Gilpatrick—That accounts for the large quantity of water used, does it not?

Mr. Weber—We use a great deal of other water.

Mr. Davisson—What is the elevation of the wells above the city? I know that they are located higher.

Mr. Weber—They are 162 feet above the pump house and 224 feet above the city.

Mr. Davisson—How far do you extend your sewers below the city?

Mr. Weber—Right below the city.

Mr. Strawn—How many cities are taking water from below the sewer district?

Mr. Weber—The nearest city is twenty-five miles. There are very few that take their supply direct from the stream.

We have a law in Indiana that the city can by ordinance have an official map made and have it recorded. This map must be presented to council as the official map. The surveys and copies from it are considered evidence in court.

The city engineer is about the same as the county surveyor in Ohio.

I have been making an official map of Richmond, Ind., dur-

ing the last year. I have made a copy of it and filed it with the recorder. It is a part of the records of the county. It was quite a task.

(Pointing to the map.) This is a fac simile of the map. Each division is numbered. Under the old law it was quite a task to make our assessments, as we had to describe the land as in a certain section. In making up the assessment of land last year of less than a mile long it took a man nine days to copy it. This map being on file, we simply refer to the plat as No. so and so.

In order to make our map we ran a line on all the streets, found out the measurements and divided them up. We fixed all our street lines and set our monuments five feet from the property line. We plant our monuments on the northeast corner. I made a tracing of it. It will make a map 15x30 inches. We file it, which is the same as recording it. A title page goes with it. It contains a title page for each addition and locality.

We also have an official map of all our sewers, our water mains, natural gas, artificial gas, etc.

Where we put in sewers we simply make a complete plat of the section, which requires a man one and a half or two or perhaps three or four days. We put all the information on it, and when we get it done it is a complete record.

Mr. Davis—After he gets through with the work and has his points all fixed, does that fix the lines of the properties and the lines of the streets?

Mr. Weber—That fixes the street lines.

Mr. Davis—How would you do when you got into the courts?

Mr. Weber—It is an official survey in court and serves as evidence.

Mr. Davis—Do you take the stand that your survey stands as against the original location?

Mr. Weber—I do not claim that.

THE PROBLEM OF SEWAGE DISPOSAL.

BY DR. EDWARD ORTON, COLUMBUS.

It is now several years since I have taken any part in the proceedings of your association, and having put off my coat I am not at all sure that it is wise for me to attempt to put it on again; but flattered by the earnest request of my young friend and former pupil, Mr. F. J. Cellarius, I have consented to occupy a few minutes of your time today in a brief consideration of one of the most important and urgent questions with which your profession is obliged to deal, the question, viz., of what to do with the products of waste, the sewage of our cities and villages.

I find much in common between your profession and the special branch of knowledge which occupies most of my thought and time, the subject, viz., of the structure of the earth, the configuration of its surface and the causes to which its main features must be referred. As engineers, you have a lively interest in the varied elevations of those portions of the surface with which you have to do. There is no more important section of your calling than that which relates to the construction of highways, turnpikes, canals, railroads and the like; or, in other words, to the providing of the best available facilities for locomotion and transportation. In this work you are obliged to determine sometimes with extreme accuracy, the variations of level of the surface, the grades of the valleys, the heights of the water-sheds and divides. For all such data the geologist depends upon your determinations, and without them he cannot do his own work with accuracy and success. Until you have traversed this state from east to west and from north to south with your canal and railroad survey lines, fixing the elevation of every part above the sea, he is unable to determine the, to him, all-important problems of the direction and amount of the dip of the coal seam or the oil rock which he seeks to follow in its underground extension.

How much, too, does he owe, in the establishment of the true geological order of a district, to the rock-cuts and rock-tunnels which your work necessitates. Such exposures of the strata he could never afford to make for himself, and yet without them how could he secure the data by which, and by which alone, accurate work on his part is rendered possible?

Then, again, there is a great deal of common interest to the engineer and geologist to the subject of building stone, hydraulic cement and other natural structural material. We base our judgments of quality, durability and strength very largely on your experience and testimony.

I am sure that the geologist ought to be enough of an engineer, if not to be able to do his work, at least to understand and appreciate the results which the latter secures. And, on the other hand, I can hardly see how an engineer dares to take up his own particular work without a knowledge of the geological facts with which his work is so closely connected and upon which it so largely depends.

But there is still another subject in which geologist and engineer have a common and mutually important interest. It is in the matter of water supply. That this subject belongs in all its practical details to the civil engineer, is universally recognized. In fact, he has scarcely a more important function than that of providing a safe and adequate water supply for the city which he serves. But in much of his work, especially in all that relates to underground water, he is, in his turn, absolutely dependent upon the geologist for safe guidance, that is, upon the men who have made a study of the facts pertaining to underground water. When we go below the surface of the earth, there is but one lamp that can direct our steps, and that is the lamp of geology. It may be that the most valuable assistance which you receive will come from some man who not only does not call himself a geologist, but who does not even hold the name in great respect. But if his observations in regard to the facts involved are accurate and his reasoning in regard to them is sound, then geologist he is, in spite of all disclaimers or denials. It is the knowl-

[illegible]

[illegible]

[illegible] are entering upon the subject of water [illegible] the subject which you are set to consider is the [illegible] of sewage disposal. I answer that it is mainly in the [illegible] of the water supply that there is such a problem. We are obliged to provide for the removal or destruction of the [illegible] of human waste, because they would otherwise find their way into the water which we use, transforming it into a [illegible] cause of disease and death. Our concern with the question of sewage disposal springs from this connection. It was largely in the interest of the preservation of our drinking water that our present system of sewage were devised and established. The foundation of modern sanitary science dates back to the investigation that followed the cholera epidemic of [illegible] in England. The intimate connection that was there established between [illegible] water and the spread of the pestilence was [illegible] a demonstration that the water [illegible] the disease. To escape like ravages for [illegible] it was seen to be essential that pure water should [illegible] and that the products of human waste should be [illegible] after the [illegible] fashion. Since that [illegible] has been immensely extended and we have [illegible] that the early conclusion reached was correct, [illegible] learned why it was correct. It has been demon-

strated that cholera, typhoid and other like diseases are propagated, each, by its own microscopic germ, and that the ordinary medium of transportation is drinking water. We know the shapes and sizes of these different microbes; we can distinguish one from the other. We know the conditions favorable for their development, and also, the good Lord be thanked, we are rapidly learning the conditions by which they are destroyed. In a word, the progress of our knowledge is thoroughly rationalizing our practice and is giving us multiplied tests and checks that can be used for our protection.

The objects of our present system of sewers are, incidentally, to lower the level of ground water and to carry away excess of rainfall; but especially and mainly, to remove the products of excretion and waste from the districts in which they originate. Manufacturing waste is also a large and growing element in the sewage of our towns. The necessity for sewers and the amount of sewage are directly proportioned to the density of population. Beyond question, one of the most striking and important characteristics of our century, and especially of the latter half of it, is the massing of population in city centers. Since the world began there has never been anything like the growth of towns that is now going forward. The steam engine applied to manufactures and transportation, is at the bottom of this unparalleled advance. The demand for sewers is thus rapidly increasing, corresponding to the growth of our towns and the centering in them of manufacturing enterprises of all sorts. Also, their vital connection with the public health and thus with the business success of the city for which they are constructed, has now been abundantly established. As to the necessity of sewers themselves, there is no longer a question. There is no problem in regard to them. But after we have got our sewers and have filled them, a very serious question arises as to what shall be done with their contents. It is certainly safe to say that our present practice is far from being satisfactory. In many instances its results become simply unendurable, if not to the town that builds them, at least to its neighbors.

I take it, you will all grant that the disposal of sewage is a

problem at the present time. I am morally certain that many of you have found it to be an urgent problem in the case of the towns which you are serving, or if not in your own town, in connection with the practice of your neighbors.

What is the present system? A few words will answer the question. Until a very recent period, at least, there was not a sewer system in the country that was not led by the easiest route to the nearest water course, whether river, creek or rivulet, into which its contents are discharged without any attempt at previous purification. In the great majority of instances, drainage water, storm water, manufacturing waste and household waste are all brought together by a common trunk to the stream. In a very few instances the household waste is carried by a separate system. There is a great deal to be said for the separate system. It can easily be converted into an immense improvement on the usual mode, but I will not dwell upon it here. Practically, the whole of the sewage of our cities is carried by the combined system. There are at the present time but two or three exceptions in Ohio to this statement.

What are the results of this system of disposal? That depends. The body of water may be so large, its current so rapid, one or both, that the town itself has no further trouble. But if the watercourse be small, or if it shrink into insignificant proportions under summer droughts, or if its current be sluggish, then we know what to look for, viz., a turbid and fetid stream, standing perhaps in stagnant pools, from which the thirstiest brute will refuse to drink, depositing a noisome slime on its bed and along its banks, bubbling and seething with the products of putrescent decay, destroying as if by specific poison all the former life of the stream, whether insect, shell or fish; and sending out to every breeze that blows over it, hateful odors that inflict almost unendurable discomfort upon those who occupy the adjacent lands. These results grow worse every year, and if the city is prosperous and expanding rapidly, the evil soon comes to be past bearing.

In many instances, there is more than one town in a valley and the stream which one city uses to convey away its sewage,

may be the only adequate source of water supply for the city that is situated below it. The sewage of the first may so poison the water that sickness and death will follow its use. The recent experience of Wheeling and Bellaire will furnish a case in point.

But thanks to the sense of justice and right, which are the glory of our grand old English common law, the state can be appealed to in cases like this. Where the conditions under which two adjacent towns were founded and have grown for generations and perhaps centuries are changed by the action of one of these towns to the disadvantage of the other, there is redress in the courts, certainly, if justice is to be found there. A more cruel wrong can scarcely be perpetrated than that which a large and prosperous town for example, may inflict upon another, a smaller and weaker one, that lies below it in the same valley, by destroying the river that once flowed through it and that brought service and pleasure alike to all and by leaving in its place a black and torpid flood that spreads malaria and pestilence as it crawls downwards.

Let me bring before you a concrete case. A small river, but clear and beautiful, that gathers its waters from upland springs and mountain lakes, flows down a rocky valley to the sea, furnishing a dozen or more excellent water powers on its way. These mill and factory sites were utilized at an early day and in many cases have been occupied for more than a century. Large and prosperous lines of manufactures have grown up there, bringing wealth to their owners and prosperity to every class of the entire community, through the wages distributed and the home markets created. One town, one factory after another, uses the water of the river for its power, gets out of it its potential energy for the level which it there occupies and sends it on, undiminished in volume and not seriously contaminated in character, to the towns and mills below. The river with its pure and sparkling water and its verdant banks is the attraction and pride of the valley. Lovely homes and pleasant parks are established along its borders. The towns are thrifty and village lot and farm alike command a ready sale. The residents of the great cities

near, when their fortunes are made, come back to the valley where their ancestral homes are still standing to spend there a part at least of the evening of their day. But while these towns are all prosperous, one of the number, situated near the head of the valley, was found, when the era of the locomotive came, to possess some natural advantage of the situation that fitted it to become a railroad and manufacturing center. It grew apace, after the fashion of successful American towns. Soon it came to outweigh and overshadow all the other towns of the valley. In due time, the thriving city recognized the necessity for drainage and sewerage and it followed, of course, the universal fashion, of leading its sewers to the nearest stream, which in this case was the beautiful river which I have already sketched. For a time no marked change is apparent to the occupants of the valley: but the city is expanding, and more and more of the water of the river and, finally, much besides is brought, clean and pure, into the town, to be sent out of it blackened, defiled and dangerously polluted—the River Rhine. Presentely the towns below are made aware that an alarming change is taking place in the river. It is not so much that its volume is reduced, as that its whole character is transformed. It has grown turbid and offensive. Its banks are lined with filthy deposits that prove fatal to the willows and alders that once adorned them. All animal life of the higher sorts flies from the river as from the jaws of death. Gravity is the only force which remains unchanged. The weight of the water will still turn the wheels upon which it falls, but the noisome odors arising from it disgust and sicken those who attempt to use it. In short, the beautiful river of the early day has been turned into an open sewer. Summer residents give up in disgust their lawns and homes along its banks; water power and mill sites are no longer in demand. All who can get away make haste to escape. The market for real estate declines, and the only purchasers are representatives of the peasant classes of old-world birth whose standards of comfort are far lower than our own. Business of all sorts falls away; the whole community is impoverished and de-

pressed; the transformation of a river into a sewer is at the bottom of all this trouble and loss.

What is the state good for if it cannot correct such a wrong as this? The great city is naturally reluctant to make the large expenditures necessary for correcting the evil that it has wrought, but from the unhappy consequences of which itself is exempt. But the appeal is made to Caesar and the legislature at last obliges the town to abandon its selfish and cruel policy, and it further maintains a constant watch upon it to see that the work of correction is properly done. Redress for such wrongs must be always possible as long as justice sways the hearts of men and wherever English law bears sway.

Thus we see that even though we can get rid of our sewage without having it return to plague ourselves, the state has the right to forbid our getting rid of it in such a way that it shall destroy the comfort and prosperity and even threaten the health and life of those who dwell below us. The state has the right to maintain the possibility of a proper water supply for all parts of its territory. It has the right to save its crystal streams from being transformed into blackened and slimy pools of filth as baleful as they are hateful. Having this right, it has no more imperative duty than to see that this work is promptly begun and efficiently carried forward.

I think I have justified the title of my paper by proving to you what probably you would have been willing to grant at the outset without any proof, that there is a problem connected with the matter of sewage disposal. Let me now take up two or three of the best solutions of the problem which the engineering and sanitary science of our day offers.

1. In the first place, I have already spoken with great respect of the "separate system" of sewers, in which the products of human waste are kept by themselves and are thus more easily disposed of than if lost in a flood of drainage, storm water and manufacturing waste. Where the ground is clear and a system of sewerage is to be begun, it looks to me as if there is much to be said in favor of the system. But in almost all of our enterprising towns, more or less has been expended already in this direction

and generally the necessity is laid on the engineer of utilizing as best he can what has already been established. Finding the combined system in operation, he sees no other way but to continue and expand it. How, then, is the problem to be solved in case of the combined system?

2. The precipitation of sewage by chemical agents, is a method from which much has been expected and on which great chemical skill and ingenuity have been expended. From what little I know of it, it seems to me to be limited in its applicability to manufacturing towns in which the sewage contains a notable quantity of iron. By the addition of lime in such cases, a flocculent precipitate of sulphate of lime is formed which carries with it the iron and much of the solid contents of the sewage. This precipitate falls as sludge in the settling basin and some value is found in it as a fertilizer for the adjacent farm lands. But while the effluent water is, in the best examples, fairly clear, it still contains all the dissolved organic matter, and notably the urine derived from the sewage. At least, the process of precipitation has no direct tendency to eliminate this element, and of course where it is present, contamination of the most hateful if not of the most dangerous character exists. The effluent of the precipitation tanks needs to be itself further treated before it can be counted purified, in any worthy sense of the word.

3. This brings me to the last solution of the problem that I shall mention. If there were others, I should not have need to name them, for this is in itself final and complete. It is no new-fangled notion that is as yet in its experimental stages. It is in substance as old as the dry land of the globe; as simple and direct as gravitation; as efficient as the oxygen of the atmosphere. Like the book of the Apocalypse, there is nothing to be taken from it and nothing to be added thereto. By the undesigned and unconscious application of it in all the past, the race has escaped countless perils on its journey from the Egypt of ignorance to the Canaan of science, to the confines of which it is already drawing near. Moses planted it in Hebrew law; China and Japan have used it for three thousand years, but with another reference. The sanitary engineer of our day gives it a common place and un-

impressive name, viz., "intermittent filtration," but let us not be led thereby to count it modern or insignificant. The method consists of "the application of sewage to the soil with intervals of rest." The soil, the finely divided portion of the earth's crust, which has been in course of preparation for countless ages, which is the result of the combined operation of all the chemical and mechanical forces that are at work upon the surface of the earth, the soil, has several all-important offices and one which ranks scarcely second to any other, is the purification of polluted water. Ill would it be for man if water once polluted, were always polluted, if there were no restorative process available in nature, if organic poison once introduced into it were obliged to remain there until left behind by the process of evaporation in the open sea, to which all the rivers run. The soil, I repeat, has this power of purifying water. The foulest sewage, even though laden with all manner of disease-breeding germs, can be completely disinfected by passing slowly through a few feet of soil. Color, odor, germs are all left behind in this short descent. Left behind, I have said, but a better word would be, "destroyed, burned," resolved into blameless elements of which they were originally composed. For when the process is complete, the poison has not been transferred to the soil, but instead it has been destroyed. The best of it is, that this agent is everywhere within easy reach. It is wider than the evil which it is set to correct. Wherever the human race can build cities and towns, from the equator to the highest latitudes, there the restorative powers of the soil can be invoked. There, human life and health can be saved from the great dangers that lurk in polluted drinking water.

The old world is in advance of us in the application of the method to cities on the large scale. Denser population has made the problem of sewage disposal far more urgent than it has as yet become with us. But it has been well begun even here also. As usual, Massachusetts leads the way. The entire country is under lasting obligation to its state board of health for the exhaustive experimentation that has been carried on at Lawrence within the last decade. In the results obtained, there is nothing

new; but coming nearer home as they do, and being wrought out in American climate and under the conditions of American life, they acquire new authority and impressiveness for us. A half dozen Massachusetts towns have already established filtration plants, which are proving completely successful from every point of view. They are mainly established in towns, it is true, whose sewage would, unless purified, endanger the water supply of Boston, and the intelligence, the influence and the wealth of that city have been the vis a tergo, "the power behind the throne," which has carried forward the work.

I spent a day last September at the sewage disposal works of South Framingham, Mass. The whole of the simple process which is there carried on was open to inspection. The town is not a large one, and but 300,000 gallons of sewage need to be treated each day. The site selected for the sewage farm is an ideal one, a sandy plain with a rolling and prettily diversified surface which in a state of nature is occupied with a scanty growth of trees, mainly evergreens. The agricultural value of the land is nil, or next to nothing, and even the real estate speculator could not find grounds on which anything more than a moderate price could be asked, for the land, even though it was to be devoted to the public service. The work of excavation and preparation are of the easiest possible sort. The land is laid off in acre plots and is thoroughly underdrained according to the demands of the system. While you are on the tract, the odor of fresh sewage is distinctly recognizable, but it can hardly be said to be decidedly offensive. The nauseating odor of stagnant sewage, undergoing putrefactive changes, is conspicuous by its absence. The surface of the lots, when I saw them, was occupied with thriving crops. Field corn proves on the whole the most successful crop, but sweet corn, cabbage, potatoes and other vegetables are also cultivated and experimenting is going on in the growing of tobacco. The corn crop commands a fair price at open sale among the farmers adjacent. For the last two or three years it has averaged about fifty dollars an acre. Of course a larger area must be used for the purification of the sewage when cultivation is to be carried on than when the sole

object is purification. In other words, the necessities of the crop must be taken into account in the application of the sewage. I watched the slightly turbid but scarcely offensive stream of sewage as it was turned, first upon this plot and then upon that, and I could not help comparing it with what the same sewage would have become if it had been turned into a shallow valley to linger in eddies and pools and fester beneath the summer sun. Thus far there was no possible offense. But the real test remained to be made. By the effluent water the entire scheme must be judged. By its character, the system must stand or fall. I made my way to the point at which the drains converge and from which the corrected sewage was flowing in small but steady streams. I caught a glass full of it in a clean tumbler and held it to the light. I never saw clearer or more sparkling water. Not a trace of odor was discernible, and knowing that it had been found to meet every chemical and biological test so perfectly that even Boston would not object to its being turned into its own water supply, I took a swallow of it in my mouth. I cannot say that I "tasted" it, for pure water has no taste. The temperature of the draught was too high to allow it to be called refreshing, but aside from this feature, no deep-seated fountain could surpass it in quality; and yet but 500 feet away this sparkling water was Framingham sewage. The united drains formed a small rivulet which followed a rather steep descent of the ground to a little creek below, leaping, sparkling, babbling, after the fashion of the best-born rivulets, as the poets describe them. Just at the foot of the declivity a "natural" spring of fair volume and historic excellence breaks out. I compared its water with the stream of corrected sewage that was flowing by, and aside from temperature, which I have already noted, the latter was at no disadvantage whatever. In short, I saw sewage transformed into spring water before my eyes, without offense at any stage of the process and with but a moderate outlay.

I said to myself, when leaving the sewage farm, would that the city engineers of Ohio, the men to whom our communities look for guidance in this most important interest, could see for themselves this marvelous transformation, this beneficent miracle

which nature is always willing to work if we but give her the opportunity. They know of course that such results are possible, but seeing the process in operation, as here, makes everything more vivid, impressive, real. With this experience they could hardly go on contentedly with the present system of defiling and ruining our rivers, of destroying the comfort of life for the thousands and tens of thousands, and of seriously endangering the public health. The sight would surely help them to persuade their communities that there is a better, a more just and fair, a more Christian way, of disposing of the waste which our cities generate than that which we are thus far using. They would see that the problem has been at last solved, and that all that is needed now is that our towns should do as well as the best knowledge points out.

The necessity for the "intermittent" application of the sewage to the land, to insure its purification, has been known for decades, but has but recently been understood. This process of purification proves to be the work of micro-organism which establish themselves in the porous soil to which the sewage is applied. The fact recalls the lines of Hudibras:

"Big fleas and little fleas,
Have lesser fleas to bite 'em,
And these fleas, lesser fleas,
And so ad infinitum."

It is to the microbes of the "ad infinitum" group that we are taught to look for protection against other microbes, that are the specific cause of our disease. Nitrogen is the most characteristic element of the animal world, and the work of these microbes of the soil is to convert the nitrogenous matter of the sewage into nitric acid, which in turn becomes an element of great importance in the support of vegetable life.

What sort of soil can be utilized in these filtration beds? Almost any sort, but the more porous and permeable the better. Fine sand ranks first, but coarse sand and even fine gravel can be turned to excellent account. So far as I know there is but one town in Ohio that has thus far introduced sewage purification by intermittent filtration. That town is Oberlin, built on the stub-

born boulder clay of northern Ohio, but even here the system is an unqualified success, according to the latest information which I have received.

In conclusion, may I remind you, that we live in the day of expert knowledge? We have been cast out from the paradise of blissful ignorance, where every man may do as he likes, and where the judgment of one is as good as another. The people of our century are beginning to find their way to the tree of knowledge of good and evil and their eyes are beginning to be opened. In the matter of water supply and sewage disposal in particular, there is a great body of settled experience now within our reach. If we cannot all avail ourselves to the fullest extent of the results of this knowledge by the thorough mastery for ourselves of the chemist's balance and the zoologist's microscope and by the opportunities of world-wide travel, we can still learn to respect and avail ourselves of the knowledge and experience of those that have enjoyed these higher opportunities. We can come to understand that without the sanction of special knowledge and wide experience our own best judgment may often "gang aglee." Audacity is an American characteristic, and judging from multitudes of its results, we might almost say it is an American virtue; but occasional exhibitions of it are met in this connection that are striking and deplorable. Men of good parts, no doubt, but without thorough training or the opportunity of experience often stand ready to lead communities on to the expenditure of millions of dollars in the most haphazard way, and to vast schemes of city engineering on which the stamp of failure is set from the beginning by expert knowledge.

Civil Engineers of Ohio, you are charged with a great responsibility. There is scarcely an important town of the state in regard to which the water supply or the sewage disposal, or both, are not today in an unsatisfactory condition. Every town has its own problems. You are hampered by the work which your predecessors have done, but they were men who tried in their day to do their duty as faithfully as you are trying to do yours. But they could not foresee the growth and development of their towns, and then, too, they had not the means at their

command for doing what was best even if they had known what was best. But you have far clearer light than the engineers of twenty-five years ago. But this fact makes your work not easier, but rather the more difficult. The engineer's relations to the public health are coming to be universally recognized.

DISCUSSION.

Mr. Harper—I have listened to the article read by the professor with more than double interest. He has given us simply one way of purifying the sewage of towns. It is what is generally known as the intermitent filtration plant. That requires, as he stated in connection with the ones in Massachusetts, a peculiar kind of soil, which does not apply to Ohio in all instances. There will be a great many difficulties in the State of Ohio to apply this to our soil. I would ask the professor, is there not some other way by which sewage can be as fully purified, as by treating it to the natural soil?

Professor Orton—I disclaim all authority in this matter, as I say, a matter of interest, but I know of no other way. I have reached, in my readings, no other way that is widely applicable. In regard to the character of Ohio's soil, I gave the instance of Oberlin, and if Oberlin is succeeding, there is no stop put to any county or town in Ohio.

SEWAGE DISPOSAL.

BY GEO. H. FROST, MANAGER ENGINEERING NEWS, NEW YORK.

I am glad to be here. It is several years since I met this society and it gives me pleasure to be here tonight. If I did not feel genuine satisfaction I would not come.

Well, the subject announced is that of sewage disposal, and it is a description of the sewage system of Plainfield, N. J. It is different from that of this afternoon, in that it is simply a personal experience, and I ask the forbearance of the meeting if it is too personal, because it is simply my own experience of what I have met with in constructing about twenty-four miles of sewage in Plainfield, N. J., last year and this. It is well to state that, while I do business in New York, I live in Plainfield, N. J., twenty-five miles distant. We have there a stone that we call "Washington's Rock." Mountains run west of us about 500 feet high. Washington's Rock is one of the places where we take visitors when they come there. It is a splendid situation from which to watch the movements of an army. Along the northern border is a range of hills, called the Short Hills. Just at the foot of the hills here we find small boulders—nothing very large. As we come to the southwest we have gravel, then finer gravel, which dies away to sand as it comes to the river. So that in constructing our sewers we met with no stones—nothing but the finest material. A great deal of it we did not have to pick at all. Another thing is that we have hardly any water. We have hardly any leakage in the pipes. In the disposal of sewage we have almost an ideal situation surrounding it. The city has about 12,000 people, but it has grown rapidly recently on account of the railroad facilities. The business portion of the city is confined to a very small territory. Most of it is confined to residences. The great army of business men move to New York daily.

The introduction of water necessitated the building of sewers. Previous to that we had the cess-pool system, and on

account of the coarse nature of the soil it was exceedingly favorable to cess pools. Some of the houses have two or three, but most of them only one. The expense of the cess-pool system is very considerable. From the end of last March to the middle of this year it cost me $29.00 to clean out two cess pools. Some house owners have paid as high as ten dollars a month. It depends upon the part of the city they are located in. The necessity for sewerage became very much of a necessity a few years ago, after the introduction of the fresh water supply.

On account of my being connected with the civil engineering profession I was elected to the city council—they said to save the expense of an engineer. I have been for three years chairman of the committee on sewers and water. I commenced from the beginning—from the first survey to the getting up of the petitions. I drew the first profile for the main sewers.

We have now built 23.65 miles of sewers. We bought fifty one acres of land for a sewage disposal farm. We are not generally allowed to issue bonds. We have to go along slowly, and at the present time we could not carry an issue of bonds for any large amount on account of the bad scare at Elizabeth.

We had several plans submitted to us and had to see which was the best one. The need of a clever attorney is very apparent in proceeding with public works of this kind. We have had a very clever attorney and so far we have steered clear of all sorts of legal difficulties.

I will say here in regard to the engineering organization that while the citizens congratulated themselves on undertaking to save the salary of an engineer, yet I felt that it would be a good thing to employ all the engineering talent that we could get on to. So we employed a consulting engineer, and had him for one short consultation. We then employed Mr. Farker, who is the consulting engineer now. We paid him $10.00 a day for such time as he should give to it. He decided the time he should give. We used every local engineer that we thought was necessary. Andrew Gavitt was made the constructing engineer and we paid him $1,800 a year. Two other local engineers were made assistants. The inspectors were to be graduates of engineering

colleges, but there were not enough of them. We could get only two or three, but they got better jobs after a while and went away. One rule that we adopted was that no political appointment should be accepted. No politician should have anything to say about it. As long as I had charge of the committee I decided that they should not have anything to do with it. In that way there was nothing provided for contracts. We got the contracts very low, because there was nothing for the councilmen.

We were very careful in our specifications as to the tightness of the joints. It was one of the things that we persisted in—that the inspector was to go down and inspect them at the bottom of the sewer. Besides that, we used mirrors for reflecting into it, so that we could see and remove any obstruction in it.

We were also exceedingly careful about the cement we used, and having once selected our cement we did not change it, so that the utmost diligence was exercised.

I felt that in putting on the students from colleges, young, bright men, who had their way to make in the world, it would not pay them to do anything but what was the very best. We only them $2.00 a day.

The agents for the different flush tanks were so persistent in their canvassing—each saying theirs was the best—that I thought I would give them all an opportunity. The seventy-five flush tanks were divided among three companies, but the Rhodes-Williams was in the majority. The man whose flush tank does not work well will hear from us.

We used mostly Ohio Valley pipe. We thought it would be a great deal less trouble to give everything to the contractor. If he could make anything out of the pipe he was welcome to it. We used the best of vitrified pipe.

We do not allow any traps from the sewer to the outlet at the top of the house. It was considered the best method.

When I was in England I visited two of the principal sewage farms there. One was five miles from Westminster Abbey. It is one of the most interesting farms in England. (Showed map.)

I show this map simply to show the nearness of dwellings to such a farm and to show how inoffensive such a farm is.

When I came on to the farm I hardly realized that I was on a farm that was at least six inches deep with raw sewage.

At this point I will say that with regard to downward intermittent filtration and broad irrigation, that the systems are almost identical. In broad irrigation the system is utilized for the raising of crops.

The soil there is the very heaviest kind of clay. It took four horses on the plow to break up the land. After several years it took only two horses to plow it.

They also have chemical precipitation. If you flood the land with the sewage you get the benefit of the filtration.

Two years after I went to Croydon. They have 268 acres—probably the finest land in England. (Showed map.)

It takes about sixty men to work it. They raise six crops a year of grass. They raise cattle to which they feed some of the things they raise. A company has taken a fifty-year lease for the grass, the milk being sold in London. At the time I was there in the middle of March, the grass was about three inches high, and one of the most luxuriant fields I ever saw. The farm houses were of the most comfortable character. Everything connected with it showed a most luxuriant landscape.

In answer to the question as to the inapplicability to Ohio soil, because you would not have the proper soil, there is hardly any soil that you cannot use in adapting it to broad irrigation. It does not have to be treated much.

Today the State Board of Health of Massachusetts are standards in sewage disposal and water filtration.

When we decided to go into this matter a committee of our council went over to Lawrence, where we met Mr. Alfred Hazen, who had charge of the experiment station. No doubt some of you are familiar with that experiment station. There is hardly anything that they have omitted. All this is under the care of Mr. Hazen. The collection of data, and the fact that they have gone over these experiments are simply invaluable to engineers. Any engineer who goes into this subject of disposal cannot do without these reports.

Back in 1878, while I was attending a convention in Boston,

in conversation with Mr. Joseph P. Davies, engineer of Boston, and now vice president and manager of the Metropolitan Telephone System of New York, he said that the great subject for engineers was sewage disposal and water purification. I am sure, from what I have seen, that this is so. There is no such field for advancement as that of sewage disposal and water purification. Mr. Alfred Hazen is considered the leading authority on that subject.

In constructing our sewers we got the very best advice it was possible to get. I will say that the cost of engineering work so far on our job has been a little over 8 per cent. of the expenses of the entire job.

The matter of sewage disposal is growing in the United States. It is not a new thing in England or in Europe. I believe that the great bulk of the sewage is disposed of on a farm, and the Berlin sewage is disposed of on the Berlin farms, and they are increasing the amount of land all the time.

The health on these farms, strange to say, is above the average of the city. On the Croydon farm, while the health of the city of Croydon is about 17 or 18, the rate per thousand on the farm is only about 7 to the thousand. The superintendent of the farm, although he has been there seventeen years, had never known what it was to have a doctor. So far as any unhealthiness is concerned, it can hardly be considered.

Professor Orton today gave such a graphic description of the South Framingham farm, and, as it coincides with my own visit, it is hardly necessary to repeat it. As he did, I drank some of the water which came from the farm, only four or five hundred feet away from the sewage. The water is better than sixty per cent. of the water that is consumed today in the United States.

At Lawrence the water is better than the majority of the water drank in London.

As long ago as 1883 there were in this country thirty-four cities that were disposing of their sewage on land. They are mostly in the state of Massachusetts. We now have three in New Jersey. East Orange was a failure. They used chemical

precipitation. They have decided to go into the tide water with a sewer which they have been building.

We made a small temporary bed and used that. The people below threatened us with all sorts of injunctions if we dumped the filth of Plainfield there. We either had to dump it there or keep it in cess pools, and we did not intend to do that. You cannot kill people with smell and there is not going to be any. Recently we turned out several weeks' screenings on that little bed and in two days it had dried up and here is a sample of the sewage. (Passed around box containing the sample.) What you see on the beds looks like wasps' nests. It is entirely odorless and is entirely disinfected.

There is nothing like earth for disinfecting. If it stood in one place day after day it would be offensive, but if you put it in one place one day and another place another day it will dry up. The sand is not used merely as a strainer, but it is a consumer.

We cannot use the streams, because the laws of the state are getting to be very rigid in regard to the pollution of the streams. There were all sorts of laws and we did not know what would spring up. So we could not run it into the streams.

This method of farming has been such a success that it is not now an experiment. The actual theory of nitrification has been so thoroughly tested that we know what it is. We are not dealing with an experiment.

The latest development of the pollution of streams is that typhoid fever germs are not killed. We used to think that if we got enough water we destroyed them, but it is now a generally accepted idea that sewage is never purified. You may dilute it and it may not hurt you, but in this case the water is purified absolutely.

You can take a glass slide, rub it with gelatine, and pass it through the air here now, and you will have a number of bacteria. These bacteria are so small that it will take twenty-four hours before you can see them. In twenty-four hours there will be the minutest spot. By isolating them you can tell the typhoid fever germs, also the harmless germs. There is only a small proportion of the germs that are dead.

DISCUSSION.

Mr. Gilpatrick—Are we to understand that those cess pools are tight?

Mr. Frost—You let a cess pool go for five or six years and you have no trouble with it, but after it is once cleaned it has to be cleaned very often. That is the reason for the expense.

Mr. Gilpatrick—Explain a little more in detail the work of the turning on of this sewage on to the fields and about the length of time that it is allowed to flow there. As I understand, you turn it on to the surface.

Mr. Frost—(Illustrating)—The sewage goes in at one chamber. This is a screen and here is a pipe that leads off into the sludge field. At the bottom we cover it up with soil. We deodorize it and it is all right in a little while. We have got to turn it on often. We can store back 30,000 gallons, by storing it up in the pipe, and turn it on as often as necessary to get rid of the sewage.

Mr. Gilpatrick—How long do you use the beds?

Mr. Frost—We put on from fifteen to twenty thousand gallons at a time.

Mr. Brown—Does the sewage from the chamber flow continuously?

Mr. Frost—We intend to let it flow continuously.

Question—What do you do with the solid sludge that you cast on the screen?

Mr. Frost—That goes on to the low ground. Then we cover it up with sand and keep covering it up.

Mr. Gilpatrick—After a while you get that filled up?

Mr. Frost—I don't believe it is possible to fill it up. We place about an inch of covering on it.

Question—What would you have done if you had a hard clay?

Mr. Frost—We would have had to go some place else. On one acre of ground you can take care of the sewage of about 500 to 1,000 people. If you are not going to drink the water you

can treat the sewage of 1,000 people on it, as it does not need to be purified so much.

Question—What is the size of the drain tiling?

Mr. Frost—Four inches. Sewer pipe or anything will do. We use the ordinary tile drain to carry the water away.

Mr. Gilpatrick—Why could you not have used the hard clay as well as they did in England?

Mr. Frost—It was used in England on broad irrigation. There they purify the sewage of one hundred people on an acre. Here they purify the sewage of one thousand on one acre. Chemical precipitation does not purify the effluent, and besides it requires a great deal of machinery and is very expensive on account of the chemicals that have to be used.

Question—How about Jamestown, N. Y.?

Mr. Frost—Jamestown, N. Y., is a small place, and I think they have chemical precipitation there. The same way with Canton, O. There is no objection to chemical precipitation, but you do not purify the effluent.

Mr. Weddal—In Mansfield, O., we are compelled to take care of the sewage. It is now turned into a small stream. There is much of the city that will have to be drained by sewers and we will have to keep below the level of the city at least four feet. Below us we have a mill dam that backs the water of the stream up and it makes it very sluggish. The soil is a very heavy clay. The question of chemical precipitation has been considered and probably a majority of our people would be in favor of that, having looked over the Canton plant, and being well satisfied with the work being done there. I have read everything that I could find upon the subject, yet I am now as far away from knowing just what to do as I was when I commenced. Now I would like very much indeed to get any information that will help me or help us. We have this trouble. We have got to go so far before we can get out on the surface with our outlet. And we have this valley that has a great deal of treacherous quick sand. If we build a precipitation plant we have got to take out this old mill dam and straighten the stream. In about three miles we can take out one mile by straightening it. If we take the plan that

is spoken of here—the broad irrigation plan—we have got the trouble with the clay, and our people might think that the amount of land necessary to dispose of it by broad irrigation, would be beyond all reason. We have about 20,000 population.

Mr. Frost—The principle in broad irrigation is that you should have the same acreage for your field that you do for your city. Berlin has an enormous territory, and they are constantly adding to it. We find that the temperature of our sewage this year has been 42, 44 and 46 degrees, mostly 44, whereas the temperature of the air was from 20 to 40 degrees.

Question—If the population of your place should increase so that your bed would be too small, what would you do?

Mr. Frost—We would add on. We find that the people adjoining the bed are always ready to sell.

Mr. Weddal—What was the cost of your plant?

Mr. Frost—Twenty-four thousand dollars.

Mr. Weddal—We thought that for $40,000 we could build a precipitation plant that would take care of everything we have. We expected that for $2,400 to $3,000 a year we could take care of all that. I have examined the effluent of the Canton plant and the water is as clear as water can be. There is no complaint from anybody on the stream below.

Mr. Brown—I would like to ask if there is anyone here who is acquainted with the plant at Oberlin. Professor Orton spoke of it as being on a very stubborn clay.

Mr. Strawn—I can tell you how you can find out. Mr. Gerrish is the civil engineer there, and if you will send to him he has a special report on it.

Mr. Judson—Professor Wright was at my house last summer and he was talking about the difficulty that they had with it. Among other things, he said one of the difficulties was because there was so much objection to it. He said he was afraid at first that a great deal of the sewage might remain on the surface, especially during cold weather. But he said they had no trouble with it at all and was satisfied there would be no trouble. The population does not exceed 3,000.

Mr. Frost—We have about fifty acres and are now using

only about one acre. We only recently commenced making house connections. We have about 110 house connections now made.

Question—What do they expect to do at Orange?

Mr. Frost—They have turned it into the tide water.

Question—Is it true that the filter beds become valueless after having been used a long time?

Mr. Frost—After a long time they lose some of their value. Then the top is scraped off and it is renewed.

Question—It is a very valuable fertilizer. I believe that if the gardeners knew of the immense amount of fertility there is in this stuff, they would gladly haul it out to their farms and gardens. At one place where they could not raise anything, by the use of this stuff they raised a crop worth $50.00 an acre.

Mr. Frost—The manure value of sewage sludge is so very small that you can never induce farmers to haul it away. There is a great deal of difference in sewage. In working a sewage farm and selling it to farmers, where you are producing a good sewage sludge all the time, they cannot use it all the time. At Los Angeles it is used for irrigation, because there is no rain there, and they want the water. There is little manure value there.

Mr. Weddal—We have to have so much land in order to take care of the output.

Mr. Frost—You cannot get away from that. You should have 200 acres for your city. Chemical precipitation would do, but it is a constant expense and you want to avoid that.

Mr. Weddal—What will it cost you?

Mr. Frost—We want to try to make it self supporting. We are going to use part of it for a poor farm. The system is built for a population of 40,000 people.

Mr. Gilpatrick—In regard to that hard soil. Cannot there be some way by which it can be treated so that it can be used for filtration?

Mr. Frost—At some places they burned a great deal of the soil, and that made it expensive to handle it. You can dig it out and haul in the proper material if you can get it.

Mr. Gilpatrick—Can it be plowed up?

Mr. Frost—If you have the material. The trouble is that it cracks and the sewage runs down into the cracks.

SEWER RECORDS.

BY HOMER C. WHITE, CITY ENGINEER, WARREN, O.

Early in the history of the writer's experience in municipal work, he realized the necessity for better methods of keeping sewer records. The old records in many cases were vague and uncertain, in fact, the preliminary survey showing the surface and grade line, quite often was about all there was of it, and if by chance references were given, locating junctions, they were made in such a vague way that, while they might be easily understood by the person making them, they were wholly or well nigh unintelligible to one who was not familiar with the progress of the work. For example, John Jones wants to connect with the sewer in front of his premises and calls upon the city engineer for information as to the location of his junction, we frankly confess that we may not be able to tell him, however we will try.

"I do not find your name on the list of owners, Mr. Jones. How long have you owned the property?" "About one year," replies Mr. Jones. "And from whom did you buy?" "From Thomas Thomas." Thomas Thomas' name does not appear on the list. We have gone as far with our investigation now as we can without having recourse to the records of deeds, and as the deed records are kept in a different part of the city, and the office boy is on an errand for the chairman of the sewer committee, we put on our hat and lock up our office, and, with our sewer records under our arm (a wise forethought, by the way), we go with Mr. Jones to the recorder's office. We learn from the records that Thomas Thomas acquired his title from Margery Williams. Margery Williams' name, however, fails to appear upon our sewer record, but the name of William Williams does appear, and we think we have a clew. Another search of the deed records is made in the name of William Williams, and a careful investigation fails to prove that William Williams ever owned any property and we are now forced to the conclusion that Margery Williams was the

wife of William Williams and the owner of the property for which Mr. Jones wanted a sewer connection, which fact was probably not known by the party compiling the field notes for the sewer record. Later we are confirmed in our conclusions by the recorder, who happens to know the parties.

Now for the sewer record: "Connection for William Williams' lot, twenty feet north of south line of lot." Easily comprehended when surrounding conditions are known. Mr. Jones now has the information he wants and we are all pleased that the problem, after all, has been solved with so little difficulty.

Mr. Jones went home, and the engineer returned to his office to find another man waiting for him who wanted to know how to proceed to make a sewer connection. About the same process was gone through with as before, with perhaps slight variations, and during the progression of investigation for case No. 2, in walks Mr. Jones, with an expression of anxiety plainly depicted upon his countenance. The engineer's salutation is: "Well, what is the matter now?" This sort of salutation is liable to become chronic with engineers, especially city engineers, if they do not take pains to guard against it. It is best to avoid giving people the impression that you are constantly anticipating trouble even though you may be quaking in your boots in fear of some dread calamity overtaking you.

But to return to Mr. Jones. In reply to the engineer's salutation, he says: "Twenty feet north of my south line brings me opposite the center of my house and I want to run my drain along the south side of my house, and as the sewer runs south it is going to be awkward for me to join the sewer at the junction as recorded; now, can't I run my drain right straight out and connect with the sewer wherever it comes?" "Yes," the engineer replys, "you can, if you care to go to the expense of procuring a new junction for the main sewer, and putting it in." "Where can I get the junction?" "You will have to order it direct from the manufacturers, as the local dealers do not keep that class of goods in stock." "And how long will it take to get it from the manufacturer's?" "That depends largely upon the state of accommodation in which your order may find the manufacturers;

it may be two days and it may be two weeks." Not at all satisfied, but unable to risk the possible delay that might be occasioned by the course which he wishes to pursue, he decides to make the connection where indicated by the record; but, before departing he propounds one more riddle for the engineer to solve. "How deep will I have to go to reach the sewer?"

"Why, you will have to go—let me see—well, the fact is, I don't believe I can tell you. The author of the recorded profile failed to indicate the vertical scale used, and it will be impossible to tell without running a line of levels from one end of the street to the other; it, however, is probably either seven feet, or fourteen feet deep, and I don't know which."

"Well," says Mr. Jones, "I won't bother you to run your level over the street. Seven to fourteen feet is near enough for my purpose anyway. I will dig down seven feet and then if I don't strike the sewer I will know that it is fourteen feet, and will just keep on digging until I come to it." And so Mr. Jones goes away the second time. But we are not through with Mr. Jones, or rather he is not through with us. Two days later he comes into the office with blood in his eye and thunder in his voice as he informs us that he has reached the sewer and there is no junction in sight.

"Are you sure you measured the proper distance from your line?"

"I measured off twenty feet, and measured it over half a dozen times."

"Did you go down straight?"

"As straight as a plumb line and uncovered two joints each side of the middle joint."

"That looks bad; looks as though there was no junction there."

"It does look just that way, in fact it is just that way; there is no junction there, and I want to know who will bear the expense of putting one there?"

"Well, you go home, Mr. Jones, and wait until I come, and we will see what can be done."

I sent Mr. Jones home, because I wanted to be alone. I wanted to look again at that Margery Williams deed.

"Margery Williams to Thomas Thomas; 50 feet fronting on Elm street * * * and being part of the same premises conveyed to the grantor by John Simpkins by deed dated June 10th," etc. "Part of the same premises!" My fears are being realized. I search the records again. Here it is: John Simpkins to Margery Williams, 60 feet fronting on Elm street, bounded south by lands owned by James McClasky, etc. I search the records again and find: Margery Williams to James McClasky, 10 feet fronting on Elm street, and being the south part of a lot conveyed to the grantor by John Simpkins, etc.

The riddle is solved; the lot line is not where it used to be. I closed the book; I started for the Jones residence. I walked slow and I kept thinking. And now you ask:

"What did you do?" "Of course," you say, "you told Mr. Jones of your late discovery upon the records—that his south line is now ten feet farther north than it was when the sewer was being constructed, and that if he will now fill up this hole which he has been two days digging (to say nothing of the strain upon his mental and moral nature), and will measure ten feet north of his south line or about in line with the south side of his house, or about in range with the line along which he first desired to dig, and to which the engineer objected, and that if he will again dig down 14 feet to the sewer in all probability he will find the much-coveted junction." Did I tell him that? Not much! We just knocked a hole right plump through that sewer. We made our junction with a piece of straight pipe, using plenty of cement and brick by way of protection, and, we did a good job. And as to the expense, Mr. Jones was advised to make out a bill for the same and present it for payment to the contractor who built the sewer for reporting connections where there were none put in.

While the writer was thus worrying with the old sewer records, and at a loss to determine the best method for recording future work, he received, in company with other members of this society, a copy of the proceedings of the 5th annual conven-

tion of the Iowa Society of Civil Engineers and Surveyors, for the year 1893, in which was reported a paper from the pen of William Steyh, city engineer of Burlington, Ia., which contained much valuable information upon the subject of sewer records. About the same time the methods adopted by the engineering department of the city of Youngstown, O., and introduced by a fellow-member of this society, F. M. Lillie, were brought to the notice of the writer.

A selection from features of both systems was made, which, combined with some of the writer's own ideas, was used in the construction of a record book which we are now using in our office, and which, while we are too modest to claim perfection for our system, we insist is a large stride in advance of the old methods.

One-half of the right hand page is ruled for profile purposes, the vertical lines of which are extended ocross the remaining half of the page, upon which is drawn the plan of the sewer, showing its location with reference to street lines, also the location of junctions, lamp holes, man holes, flush tanks, catch basins, lots, lot frontage, No. of lot, and name of owner, also location of buildings. Upon the profile is shown surface of street, size and kind of sewer, with grade of same, also lamp holes, man holes and flush tanks, and rock or quick sand. Upon the opposite page is spread the field notes, giving the location of all objects noted upon the plan and profile. Objects are located by means of the total distance of the same from the outlet of the sewer, which is designated as station O, thus: A junction 560 feet from the outlet of the sewer is noted at station 5x60; the west side of a house is observed from the line of the sewer at station 5x75. A measurement of 15 feet from a point on the line of the sewer in range with the west side of the house is an expeditious way of locating the junction.

It will always be best in locating junctions in this way to make measurements from several recorded objects, for houses as well as lot lines are liable to be moved or additions built on. To rely altogether upon measurements made from man holes is objectionable for the reason that, especially on unimproved

streets mud is liable to accumulate over them, making it necessary to hunt for them with a pick and shovel when needed.

Our record also provides for registering connections when made, giving number of house, street, name of owner of property, name of plumber and date. Once understood that a careful record of connections is being made, the plumber will have an additional incentive to do good work. To further facilitate accurate record of the work, printed slips with perforated tabs attached, and put up in convenient tablet form, should be obtained, upon which can be entered the name of the owner of the property, the name of the plumber, date of work, name of inspector, etc., etc., the slips to be given to the applicant as his authority for making the connection, the tab to be retained in the engineer's office, and when complete, or at any future convenient time, the contents can be transferred to the regular record book, which may be styled the ledger.

The composition of these slips would vary with the practice in different localities; with us it is necessary to get a "permit" from the mayor before excavation can be made in the street, while inspection of sewer connections comes under the supervision of the engineer or his "duly authorized assistant," and the practice with our people has been for the mayor to issue "permits" with verbal instructions to the applicant to call upon the engineer for further information and when the work was ready for inspection.

This he was pretty sure to do without instructions from the mayor if the sewer happened to be an old one, but in several cases, on new work, where the location of the junction had been marked by boards coming to the surface of the ground, the parties failed to appear at the engineer's office and before the engineer knew that the work was being done, the connections were made and covered up.

The mayor being apprised of these facts, in the future required the applicant to produce a written statement from the engineer before permission was granted to make the excavation, and for this purpose printed slips addressed to the mayor with accompanying tabs for the engineer's office as above mentioned,

were supplied. Good results were obtained by this method, but following events proved that the plan was not complete. The engineer was horrified one day upon observing parties just completing the refilling of a trench for which permission to open had been obtained a few days before with instructions to notify the engineer when ready to make the connection, and to his certain knowledge no such notice had been received. In addition to the requirements of our ordinances regarding inspection of our sewer connections, a penalty of fifty dollars for the violation thereof is imposed. This is not generally understood by the people. To overcome the above objectionable features, we propose making some changes in our present system of issuing permits, which, when completed, will be about as follows:

TAB RETAINED BY ENGINEER.

Date......................

Name of owner of property..............................

Name of plumber...

Location of junction......................................

Inspected by ....Date............

SLIP RETAINED BY MAYOR.

Date...............

To................, Mayor:

This is to certify that......................has made arrangements with the city engineer for the inspection of a sewer connection to be made by him for.....................on .... street, subject to permission from you to open street.

.................., City Engineer.

SLIP TO BE RETURNED BY APPLICANT.

Junction for sewer connection for............., owner of lot No. ...., on............. street, is located as follows:

....

................, City Engineer.

Work inspected and approved by.........., Date......

..................,

(See other side.) Inspector.

On the reverse side of this slip will be printed the ordinances relating to the inspection of sewer connections and the penalty attached to their violation. If this is not found to be sufficient to accomplish our purpose, about one dose of heroic treatment in the way of a fine will settle the matter.

It is hardly possible to do justice to the subject of sewer records without a consideration of the methods employed to gather data for the record, but as this paper has already attained a much larger size than we intended it should, we will only say that measurements should be taken to all junctions before they are covered, and these measurements should be verified before adopted. In order to do this it will be necessary that a competent inspector be kept constantly upon the line of the sewer during the progress of the work.

A careful inspection of the system of sewer records adopted in this city (Dayton) will repay any one who is interested in such matters.

SOME NOTES ON A COMBINED WATER-WORKS AND ELECTRIC LIGHT PLANT.

BY J. B. STRAWN, C. E., SALEM, O.

Most of the thrifty, live, go-ahead cities and villages of the country are taking hold of municipal improvements with a zeal that is truly commendable. Villages with a population of two or three thousand are now enjoying luxuries in the way of improved streets and sidewalks, efficient sanitary works, as sewerage, drainage, removal of house and factory waste, electric lights, water-works and electric street railroads, with almost all other improvements now enjoyed by the larger cities. All of these improvements, until recently, were thought to belong to the great cities, where great wealth is at hand to meet the necessary outlay to procure these conveniences and luxuries. A careful study of social economics has shown that these improvements which have been regarded largely in the sense of luxuries and conveniences, and by many are considered extravagant outlays to gratify the select few—the wealthy—are really the greatest boon to the humbler classes; and, very especially to the poorer classes.

Sanitary science most clearly shows that these improvements not only add much to man's comfort and happiness, but they add to his wealth, his length of life, to his general enjoyment—to a better, a more useful and broader life. Society is improved by bringing to it greater comfort, larger conveniences, and by adding increased security to life and property.

A few years since the writer was called to one of Ohio's beautiful county seat towns to confer with the council with regard to a public water supply. The town had but little in the way of permanent improvements, aside from its few well improved streets and a fair amount of good sidewalks. There were no facilities for coping with large fires. True, there was a river, also a canal running through the town, and the town owned a

good steam fire engine, with a reasonable amount of fire hose; there were a few cisterns—generally in bad repair—dry in summer, and full of water in winter. A large portion of the town was without any protection from fires. The place had been more than ordinarily fortunate in having had but few disastrous fires. And for this very reason many of the taxpayers and better citizens thought it unwise in the council to agitate the question of having water works. As there was a private party in town who owned a small electric light plant that furnished scarcely half as many street lights as would light the town fairly well, but little had been said about the town putting in an electric light plant. There were sixteen arc lamps for lighting a town of four thousand people, and the houses were badly scattered. The pole line was something of a curiosity; the poles were of various kinds of wood, sizes and heights; ranging from large-size bean poles to something larger. The wires in places hung so low as to be used on washdays to hang clothes on to dry. Throughout the plant was unique. Many of the citizens thought this a fine plant, good enough for any town. And as for water for general uses the supply was insufficient and of suspicious quality, when viewed from a sanitary point of view. A better water was greatly needed for drinking purposes. Some did drink water.

There were others who wanted to see the town have waterworks, but favored the granting of a franchise to private parties to put in a plant. This side had advocates who ventilated their views through the press, and as a result there were parties at this time figuring on plans, and proposing to furnish the place with a water supply.

Possibly the invitation to the writer to visit the town at this time grew out of the fact that one party had been there for about a week, working up his case, and the council doubtless thought it would be well to investigate the other side of the question, viz., the propriety of the town putting in the plant and operating it.

The party who was on the ground had prepared a map of the town, upon which he had sketched the street mains, and shown the fire hydrants, stop valves, etc. He had no plans for pumping station, nor had given any data for the standpipe. Nor was the

water supply determined upon. The party, however, said that he had very carefully figured out the cost of the proposed plant, which would be very complete in every detail, and first-class throughout. The writer listened to the gentleman who was seeking the franchise, as he went on to point out the superiority of franchise plants over municipal plants, of their ability to build more economically, and build better works, and of the advantage that a firm putting in numerous works had over a town which put in but one plant; they could purchase material and machinery so much cheaper; they "had the inside track on every hand." He went on to say that he had made a careful study of the town's needs, and he had figured on a plant that would fully and amply meet all their requirements and needs, not only for the present, but for many years to come, and as soon as the plant became insufficient to meet the demands they would make all needed extensions, free of any cost to the town. It certainly would be a very generous town that would, after granting a valuable franchise to a private company, go on adding street mains and fire hydrants for a company—"free of cost."

This party assured the council that he had gone through most carefully with his calculations, taking in all items in detail; and again reminded the council of the ability that his company would have over the town for economical management in construction; that they could buy to so much better advantage, as they were acquainted with the markets and knew where to to buy the best pipe, hydrants, pumps, boilers and, in fact, everything that went into the plant they could buy much cheaper than the town could buy, and get better material, and they could do so much better work on the construction than the town could do if they should think of building their own works. He said that if the town had any notion of owning the plant, they should let some firm that knew all about building water works put it in for the town, and then the town should pay the company the estimated cost, with an addition of fifteen per cent. of the estimated cost, which was to be considered as covering incidentals and risks which they would have to assume for any damages that might be claimed. "But, first, let me give you

my figures for the plant which I propose to build you." Here he read off, with much deliberation, the cost of the several items enumerated in his memorandum, making extended comments, and bestowing loud praise on material, design, workmanship—everything inside the plant, and outside, too, was the best—far better than was possible for the town to furnish or build.

The price named for the complete plant was considerably more than double the cost of several works for towns of about the size of this one, which the writer had, in his correspondence with the council named, as approximate cost for a suitable plant for this town. The franchise party had also at hand the names of several towns, with the cost of their works, some of which had cost considerably above the figures he had quoted for the plant under consideration. The towns named had been selected from the franchise plants as reported in the Manual of American Water Works. Not one of the plants cited had been truthfully and honestly reported. The writer can speak advisedly on two of them, as he had been engineer on the construction of them. One of these plants is reported in Manual of American Water Works as costing $149,000. The other as costing $200,000. The first cost about $55,000. The second a very little over $100,000. As there was a copy of the last issue of the Water Works Manual at hand, it was not difficult to set these widely different figures in their true light, when called upon "to rise and explain." It is through deceptions like these that most of the franchises of the past few years have been obtained. The day of granting valuable franchises to private parties to put in public water supplies is practically a thing of the past.

The persistence of interested parties in publishing and representing grossly false and unwarranted figures as to the cost of public water supply plants has done more to retard improvements along this line than all other influences combined.

Again, the service rendered is, ordinarily, better where towns own their own water works than where owned and operated by private parties. The prices for water are, as a rule, not so high in the case of municipal ownership as in the case of private ownership.

Another important consideration favoring municipal ownership of such works is this: The revenue arising from hydrant rental and from domestic service in the case of private ownership, as a rule, goes to some other city; whereas in the case of town ownership the earnings of the water works remain at home and circulates among those who pay for the plant. The town does not seek to make money out of the plant, as an investment, but to furnish its patrons water as cheaply as economical management will allow.

After a full and fair presentation of the two methods under which such public improvements are built and operated, the council decided it would be better for the town to build and own their works. The writer was engaged to make the necessary examinations, surveys, estimates, etc., and make a formal report and recommendation to the council for their consideration and action.

There were many reasons favoring a better water supply. The ground on which the town was built was flat; the drainage was bad. Some efforts had been made to provide sewers on part of the streets, but these were ordinarily constructed with common open-joint agricultural drain tile, good to let water in during wet weather and to let water out during dry weather. The wells fluctuated from being full in wet seasons to that of being empty in dry weather. Under such conditions, the water in many of the wells was of suspicious character, to say the least, and it could not, under such circumstances, be other than seriously contaminated in many instances.

The Maumee river seemed to be the only available water supply. On general principles the writer did not favor river water for the town supply, but repeated analyses and microscopical examinations both gave very satisfactory results. Investigation also showed that the city of Toledo was supplied from this river with water for all purposes. Also, that Toledo had the lowest mortality rate of any city of equal or greater population in the United States. These favorable showings, coupled with the fact that all efforts to procure another supply had been futile, decided the question. It must be river water or no works.

In the report to the council considerable space was given to the sanitary influence of an efficient water supply, as well as increased security to life and property, and, added luxuries in many ways, as baths, lawn sprinkling, washing pavements, street sprinkling, flushing sewers, etc. In the report it was recommended that the town put in a combined water works and electric light plant. The electric light plant then furnishing lights was not capable of supplying half as much light as was really needed, either for street lighting or for commercial purposes. The pole line was worthless, and the wire was badly damaged and of little worth. Practically speaking, the crude little plant had served its time, and was ready to be relegated to obscurity.

The council at once favored the combined plant. It was recommended that there be duplicate machinery, as two pumping engines, each of 1,000,000 gallons capacity in 24 hours, two boilers, each of sufficient capacity to run either the two pumps at the same time, or the two high-speed engines for driving the dynamos at the same time. The pipe and distribution system would consist of about eight and a half miles of street mains, seventy-six hydrants, fifty-four stop valves, three watering fountains, standpipe 20x125 feet, and dimensions were given for the building to be used for the plant.

All of the above work as herein outlined was new to both council and trustees; none of them had seen such a plant. The trustees were now formally in charge of the proposed plant, and they were desirous of going at the work as fully equipped as possible. It was decided to visit certain plants, where combined works were in operation, that they might judge of the practicability of such plants and to get what information they could as to the satisfaction they were giving, cost of same, running expenses, etc. This tour of examination fully satisfied the trustees that a combined plant was not only feasible, but it was the best thing for their town to build, both for economy and convenience.

In due time plans and specifications were prepared in accordance with the recommendations given, with full detail drawings for building, standpipe, pipe and distribution system, the location of all the hydrants, valves, blow offs, and as the river

had to be crossed with an eight-inch supply main for the south side of the town, careful surveys were made in numerous places in order to find the most desirable location for laying the pipe. A satisfactory location found, the line was accurately profiled and made a part of the plans. Blue prints were made in triplicate of all of the drawings and maps. One set was to be filed with the council, one for the contractor and one set for the engineer.

After the plans were fully matured, the specifications completed ready for the printer and all of the details carefully worked out, covering all of the points set forth in the engineer's report, the trustees were recommended to advertise the works in three or four of the leading engineering and contracting journals. About 300 copies of specifications were printed, yet there were not enough to meet the demand and to have a sufficient number for use of trustees and other officials desiring copies. The writer answered over 200 letters of inquiry pertaining to this plant. On the day appointed for opening proposals for the works—the bids covering material, machinery and labor—there were 105 bids that were regular, and in all respects according to advertisement. This was on June 20th, 1893. On the same day $60,000 in bonds were offered, but there was not one legitimate bid received. It was just in the beginning of the panic. Nothing more could be done. No money—no works. The bids for material, machinery and labor satisfied all parties, who heretofore had been skeptical as to the possibility of the town being able to build the works; and, safely within the authorized amount.

The spring of 1894 showed signs of returning prosperity and confidence in financial circles. The bonds now were in demand. The council were about to issue the bonds under an act of the Ohio Legislature passed in 1893, when injunction proceedings were brought to restrain the council from issuing the bonds. The case was carried through the courts, and the council were enjoined from issuing the bonds on the grounds of unconstitutionality of the law authorizing their issue. The matter was again presented to the citizens and another vote was taken. "Issuance of bonds" carried by about five for to one against.

Plans were revised, new specifications prepared, and the whole case went through the mill again. This time there were 74 proposals that were regular, and were considered. The bonds had been sold at a fair premium. The bids for the material and construction of works being much lower than they were in 1893, the difference being over $6,500.

In the selection of material and machinery, the motto of the board of trustees was, "The best is none too good." This was the keynote which the engineer endeavored to follow from the time of awarding the contract—through to the completion—testing and accepting of the plant.

By reason of the high price of coal at this place, special thought was given to the matter of economy in this direction. The steam plant is possibly worthy of notice. The boilers were made heavy enough to safely carry 125 pounds of steam. The brick stack is double-flue and 75 feet high, and is located outside the building at the rear end of the boilers.

The boilers are tubular, 66 inches by 16 feet long, with 64 tubes each. The boiler walls are built with an air space in the brickwork to prevent, as far as possible, radiation of heat. The smoke is returned from the "uptake" on front end of boilers through brick arches turned over the boilers. The arches are turned over Tee irons bent to the proper form. The arches come together just beyond the rear end of the boilers, and from there to the wall of the building; and thence to the smoke stack the smoke is carried through a brick arch. At the rear end of the boiler walls, which are 24 inches from the wall of the building, an arch is turned from boiler wall to building wall which carries the brick smoke connection, which is also arched, but in opposite direction. A similar arch is turned from outside of building wall to the wall of the stack—the space being about 36 inches between building and stack. The space between building and stack and under the smoke flue is designed for the engineers' water closet. There is no sheet metal flue for conveying smoke from boilers to stack. A damper is placed at the point of the deflecting wall where the smoke coming from the two arches over the boilers are merged into one. The damper stands

parallel with the boilers when both boilers are in use. When but one boiler is used the damper is turned and closes the flue from the idle boiler. There are dampers to each boiler in front. Thus, with the double damper arrangement, the draft is under complete control. The boilers are without steam domes.

The steam piping is all covered with best quality of "long section" non-conducting pipe covering. One word as to the manner of putting up steam pipes. The piping should be provided with a sufficient number of flange-unions, in large-sized pipe, and ordinary unions in small pipe, to allow any part of the piping to be taken down without removing any other portion. We have seen steam piping where the only union between boiler and engine was that used in making the final connection to the engine. Such work should not be allowed. The piping should be as direct as practicable, and with as few elbows as possible, all work should be symmetrical and true.

The piping on the plant which we are considering was done by the Shaw-Kendall firm of Toledo, and is very complete. The main steam pipe receives the steam at the front of the boilers through five-inch branches. It is eight inches in diameter, and is carried in straight line a distance of fifty feet. Branch pipes are carried from this eight-inch header to the high-speed engines and to the pumping engines. Each branch is provided with two valves.

Engines—The engines for driving the dynamos were built by the Watertown Steam Engine company, of Watertown, N. Y. Both engines are of the tandem compound pattern and are run condensing, having a nominal 125 H. P. each. They are of special design. and built after plans and specifications furnished by the writer. The engines are handsome and do their work very satisfactorily. Most of the polished surfaces of the machinery are nickel-plated. The engines are connected with "Jack-shaft" and friction clutch pulleys operated by the levers. Either engine can easily be thrown in gear or out of gear while running at maximum speed, without a jar.

The electrical machinery was furnished by the "Ft. Wayne Electric corporation," of Ft. Wayne, Ind., and consists of one nom-

inal 60 arc light dynamo of nominal 200 c. p.; one 75 k. w. wood, compound alternator and exciter. There is at present about nine miles of "arc line," with 36 arc lamps on the streets, and four more ordered. The lamps use single carbons of 14 hours burning. There are 1650 16 c. p. incandescent lamps wired in.

Pole Line is one of the neatest to be found. Poles are of live cedar—remarkably straight and are truly aligned and well painted. The electrical part of the plant is provided with handsome marble switch-board, on which are mounted all indicating instruments and lightning arrestors.

Pumping Machinery—The pumping machinery was furnished by The Stillwell-Bierce & Smith-Vaile company, of Dayton, O., and consits of two vertical duplex-compound, condensing 1,000,000 gallons each in 24 hours. Cylinders 10x18x18. Water plungers are of the differential type, 11¼ and 14¼ inches. Heater, "Stillwell-Bierce;" surface condenser, "Wheeler;" vacuum pump, duplex boiler feed pump, oil separator, steam trap, back-pressure valve, with pipe and valves forming a bypass for flushing intake pipe from standpipe pressure. Provision was made, in designing the pumping machinery, for turning live steam into the low pressure cylinders when large quantities of water might be required for fire service. The height of pumps from bottom of water end to top of steam end is 28 feet, 10 feet of which stands above the principal floor line. The steam cylinders are cased in mahogany, with heavy nickeled bands and ornamental nuts and fittings. Heavy polished brass railings are provided for the iron stairs extending to the upper iron platform surrounding the steam ends of the pumps, which platform is also provided with brass railing.

Standpipe—The standpipe is a neat, plain piece of work 20 feet in diameter and 125 feet high, and is located on the same lot occupied by the pumping and lighting station, and was built by the Mansfield Machine Works company, of Mansfield, O. Special care was given to the quality and thickness of the plates forming the pipe. The standpipe is covered to prevent anything from entering it from the top—is also provided with necessary valve and overflow. The foundation is 11 feet deep and 36 feet

Combined Water and Light Plant, Napoleon, O.—Engineer, J. B. Strawn, Salem, O., 1894.

in diameter at the base and batters to 23 feet diameter at the top, or coping course. The base of foundation is of Portland cement concrete 18 inches thick, the balance of foundation is of heavy dimension stone, laid in regular courses and grouted with concrete grout.

Building—The building is of brick of excellent quality and color. The stack is of same kind of brick. All brick work except the walls in the pump pit is laid in lime mortar, with one barrel of cement to three of lime, mixed with a very superior river sand. The conditions for securing a superior quality of masonry were very favorable. The building, in design, is both neat and handsome, and it has many special features of convenience. The storage for coal is about five car loads, and the coal room separated from the boiler room by a brick wall, is convenient to boilers. Platform scales are located on a level with the floors of the boiler room and coal room and in the doorway between the two rooms. Every pound of coal is weighed before it goes into the furnace under the boilers. The boiler room is ample in dimensions, and is provided with bench and outfit of tools for making all manner of repairs. The engine room is separated from the boiler room by a brick partition—a large door with glass panels communicates between the two rooms. The engine room is finished in three coat plaster, wood work all oak, filled and hard oil varnish, except the ceiling, which is soft wood painted. The room is 30x56 feet and 18 feet ceiling. It has been said that this plant is the best one in Ohio for the cost, $60,000. Certainly it is a very handsome plant as well.

For the benefit of those who may be interested in the item of expenses for running such a plant, a copy of the engineer's report for the last six months in 1895 is here appended:

Notes on Napoleon Water Works and Electric Light Plant—Work Performed and Expenditures of Plant for Last Six Months, 1895.

ARC LIGHT CIRCUIT.

Month.	No. Lamps.	Hours Run.	Lamp Hours.	No. Watt Hours.
July	33	146.5	4834.5	2.417.250
August	33	168.5	5560.5	2.780.250
September	33	219.33	7337.89	3.618.945
October	33	170.16	5615.28	2.807.640
November	33	257.33	8491.89	4.245.945
December	35	271.75	9511.25	4.755.625
				20.625.655

INCANDESCENT CIRCUIT.

Month.	Lowest No. of Lamps on	Highest No. of Lamps on	No. Hours Run Circuit.	No. Watt Hours.
July	20	660	311.92	2.496.000.0
August	20	720	337.33	2.504.584.1
September	20	820	364.16	4.359.297.4
October	20	860	395.33	6.020.546.5
November	30	920	447.66	7.181.957.1
December	30	1050	787.50	8.477.785.0
				31.040.170.1

Total Watt Hours, Arc Circuit	20.625.655.0
" " " Incandescent Circuit	31.040.170.1
" " " delivered in the lines	51.665.825.1
" " " " " " =	69.257.135.5 H. P. Hours.
Total Water Power delivered	12.542.014.0
Total Electric Power delivered	69.257.135.5
Grand Total Power delivered in six months	81.799.149.5

NOTE.—The foregoing data was furnished by V. R. Hughes, Engineer in charge.

DISCUSSION.

Mr. Bone—Tell us what it cost, how much for the water and how much for the electric plant.

Mr. Strawn—The bid that was received for the original contract for the water and electric light plants complete, was only about $49,000. But the trustees wanting, as they said, to use every dollar of that money for the building of that plant, therefore selected very much better pumping machinery, and all other materials better than what had been bid for. The electric light machinery put in cost about $7,220. The balance of the plant ran up to something over $50,000. The whole plant cost about even $60,000.

SOME FEATURES OF THE PORT CLINTON WATER WORKS.

BY C. E. DEWITT, PORT CLINTON, O.

By way of explanation I will state that Port Clinton is the county seat of Ottawa county, O., and to use the words of the description given in the original plat of the village, is "A parcel of land lying at the mouth of the Portage river in the above named county and state."

The town today has a population of about three thousand, and a little over a year ago was struck with that wave of progress and improvement that is so common to the small towns of Ohio.

Bonds were sold to the amount of $42,000 for the building of a system of water works, and the writer was selected as consulting and constructing engineer, that being his maiden effort in filling so responsible a position in that branch of the profession. He had, however, good advisors in the persons of Mr. Charles A. Judson, of Sandusky, and Mr. O. J. True, of Port Clinton, both men of large practical experience.

Now that the system is in operation and has been pronounced a success and good in every particular (by engineers of more eminence than your humble servant), we naturally take some pride in the fact that our first effort met with no failure.

Now, if you will bear with me for a few moments and overlook my poor rhetoric and imperfect delivery, I will endeavor to give a brief sketch of the plant and will be glad to listen to any criticism or suggestion in regard to the same.

The system of force mains comprises about seven miles of piping of sizes ranging from six to fourteen inches in diameter; no pipe of smaller diameter than six inches being used, and the town is platted in such form that no dead ends were necessary, and, in fact, each of the sixty- seven hydrants used, would, with all the valves open, receive pressure from the entire system.

The pipes are covered to a depth of no less than three and one-half feet, the greater part of which is a stiff yellow clay, which rarely freezes to a greater depth than two feet.

The source of supply is Lake Erie and is taken through a sixteen-inch castiron pipe, which is laid under the Portage river to a depth of sixteen feet below the surface of the water and thence out into the lake at a less depth; but at all points sufficiently below the hydaulic grade line.

The intake is a little more than 2,400 feet long and was laid from a scow or raft built of logs and plank, for the purpose, and which had an opening of about three feet in width from the center to the rear end, through which the pipes were lowered gradually after being calked.

The pipe used for the intake was manufactured by the Addyston Pipe and Steel company of Cincinnati, about one-third of which were of their special pattern of flexible joint, and the balance were the ordinary bell and spigot pipe. These flexible joints when properly calked may be safely deflected so as to describe an arc of eight or ten degrees without danger of leakage, and in the entire length of 2,400 feet only a few small leaks occurred, which were easily stopped by a few strokes of the ordinary calking tools.

At the outer end of the intake in ten feet of water, will be built a crib 36 feet square outside, with a 12-foot square inside pocket or well, and the space between will be filled with broken stone or gravel.

From the fact that a portion of the intake (that part beneath the river) is below the level of either end, the tendency will be for that lower portion to partly fill with sand, and for the purpose of remedying this defect, we have connected the pumps with a secondary intake to the river and have provided an arrangement for flushing or blowing out whatever material may be thus deposited.

To do this successfully it becomes necessary to carry the deposits entirely outside of the crib, for which purpose we have an automatic check valve, of our own design, at the crib end of the pipe, which closes when the pressure is reversed or turned against it, and the outflow passes through a six-inch pipe provided with a check valve and also a gate valve, which pipe leads from the automatic check valve to the outside of the crib.

By means of the gate valve in this pipe, any desired pressure, within the limits of the pumps, can be maintained on the main intake.

For better comprehension of my meaning I refer you to the plans I have with me showing the arrangement in detail.

Inside of the pumping station the arrangement is, I believe, a little out of the ordinary. The pumps are connected with the sixteen-inch intake with ten-inch suction pipes, at the junction of which with the main pipe we have an ordinary piece of sixteen-inch pipe about eight feet long for a compression chamber, and at the junction of the eight-inch force pipes from the pumps with the fourteen-inch force main is a piece of fourteen-inch pipe of about the same length for the same purpose.

These, together with the compression chambers provided with the pumps, form such cushions that water-hammer is almost an impossibility.

We were at first troubled with aerated water; the quantity of air in the water being so great as to render it to an almost milky whiteness. This of course was in no way detrimental to the water for domestic use; but it interfered somewhat with the working of the pumps, and the water takers, perhaps not understanding the cause of it, raised serious and vigorous objections to it, so that we were compelled to devise a plan for eliminating the air, which we did successfully by inserting a half-inch pipe in the air or compression chamber over the force main and just above the upper line of the force pipe from the pumps, and carrying it thence to a waste pipe. This air valve, though only a piece of ordinary pipe is, in its workings perfectly automatic, the air escaping until the water rises to the level of the pipe, when water escapes until the air again forces it down. This goes on continually, the change to air or water taking place in intervals of only a few seconds, thus keeping the water level in the force main within the extremes of about one-half inch.

The pumping machinery consists of two horizontal compound duplex pumps of the Laidlaw-Dunn-Gordon manufacture, of the size 10x16, 10¼x18, each of which will deliver one million

U. S. gallons in twenty-four hours with a piston travel of eighty-one feet per minute.

The eighteen-inch stroke was made a special order for us, as the lift does not exceed twelve feet and is ordinarily only about eight feet.

We are at present pumping about two hundred thousand gallons in twenty-four hours, with a consumption of about 1,800 pounds of coal, and carry a domestic pressure of 50 pounds, with a steam pressure of 60 pounds. We pump direct, using the Fisher governor.

We have two horizontal boilers 16 feet long, 60 inches diameter, with 50 4-inch flues, which give excellent results.

The pumping station and stack are built of brick and are located in a neat little park on the lake front about midway between the extreme ends of the town.

The main part of the building comprising the pump room and office is 36 feet square and the rear part or boiler room is 24 feet by 40 feet.

The site upon which the building stands was, about twenty years ago, navigable for boats drawing four or five feet of water, but has since that time filled with sand washed in from the lake. The foundation was built in this sand and was extended to a depth of only about one foot below the surface. The sub-foundation was made of concrete in a layer one foot thick and three feet in width upon which another layer of concrete was placed, being two and one-half feet wide and six inches thick, and from that up was built of building stone.

The foundation for the stack, which is 50 feet high, 8 feet square at the base, with a 38-inch flue, was built in the same manner, and notwithstanding the many imprecations and warnings of the older and wiser heads about town and their prophecy that both building and stack would be out of sight in less than three months, they still stand, and without a crack or any perceptible settling.

The plant is owned by the town and has so far paid about two-thirds of the running expenses, which fact we take as an indication that it will, within the next year become self-sustaining.

DISCUSSION.

Mr. Gilpatrick—What did it cost?

Mr. DeWitt—Forty-two thousand dollars.

Mr. DeWitt showed some drawings to the Society of the water works.

A NEW SOLAR TRANSIT

AND THE PRINCIPLES ON WHICH ITS CONSTRUCTION AND OPERATION ARE BASED.

BY J. B. DAVIS, CLEVELAND, OHIO.

Distances and courses are used in instruments of conveyance of real estate and in the perpetuation of surveys by record, except where sub-divisions are made in villages and cities and conveyance of sub-lots made by lot numbers, and in sections where the government in its sub-division of public lands has employed the rectangular system of surveys.

The use of courses and distances is perhaps the most simple and comprehensive method that can be used, outside of the exceptions above noted, but whether it be so or not, the fact remains that long custom has decreed that this method be the one employed.

The lines of a survey are usually marked or monumented by the surveyor, but unfortunately not always done in a suitable or permanent manner, and these markings are not always recorded in the instruments of conveyance.

The markings of these lines even when properly done are liable to be lost or destroyed by carelessness, or by those ignorant of their value; so that sooner or later the surveyor is called upon to retrace these surveys, and with what difficulty, when the causes in the original survey were taken by needle and the monuments then set, lost or destroyed, only the surveyor knows. All he can do is to look to occupancy, or adjacent surveys for help; or if you can find an original corner to start from, be satisfied with the limit of error in a needle instrument, determining as near as

may be the difference in the length of the chain used by himself and the surveyor who made the original survey.

These perplexing problems will abide with us and there is no remedy until such a time as modern or more accurately made surveys supplant the original ones; and the foregoing will apply to the rectangular system of surveying U. S. lands, so far as the relocation of sub-divisional lines may be effected by the uncertainty of the indications of the magnetic needle.

But what I wish to call your attention to more particularly is, what I will term an inconsistency in our modern surveys of lands, in which increased accuracy is demanded on account of increase of values, and in which measurements are more accurately made, a transit instrument used, and more care taken in the matter of monumenting, such surveys being with little difficulty retraced, providing monuments sufficient are left from which to start.

As custom has prescribed the method of description, we still use courses, determined not by the needle, as originally, but by deducing the bearings from the transit angles taken, using as a base the bearing of some one line, either taken in the field or from deed, and right here comes in the inconsistency referred to; we care nothing whether the bearing of the line we start from be a true one or not. We are well satisfied if it be only approximately true; we rely on the harmony of our survey, the fact that we have set monuments, taken the angles with a transit instrument, been careful with our measurements, and assume that there can in the future be no difficulty in retracing the survey we have made; but mark you, the bearings of the lines in this modern and accurate survey, taken individually, mean absolutely nothing so far as the retracing of an accurate survey is concerned, only collectively are they of any value.

If we are to make an accurate survey, and are by custom forced to the use of bearings in our descriptions, why not have these bearings mean something, and be equally consistent with the balance of the survey; but this is not all; monuments are lost, and the cases are not infrequent when but one can be found,

and then the trouble begins, and care and good judgment are required in the solution of the problem.

The remedy is the referring of the survey to the true meridian; this can be done by observing the north star, or an altitude of the sun, or by solar instrument.

I find that surveyors do not take very kindly to observing the north star, they objecting to the night work requisite, and will resort to it only when absolutely necessary.

The method of determining azımuth by an altitude of the sun does not seem to be popular, as requiring too much time in the solution of the spherical triangle.

It has been claimed that solar instruments or attachments are not sufficiently accurate and certain in their indications to be used in transit surveys.

In the year 1894 a committee of this society, of which the writer was a member, was appointed; they to test the accuracy of the indications of solar transits.

The report of this committee will be found in the last annual report of this society.

The committee succeeded in getting together solar instruments of all the prominent makers except one, so that ample opportunity was had for tests. The conclusions of the committee were that solar instruments as constructed might, with skilful handling, be relied upon to work within an arc of two minutes; providing, however, that a known and accurately established meridian could be had on which first to test them. To make this more clear, we found that after the most careful adjustments all observations taken with care would fall within an arc of two minutes, and that when the sun was brought into its proper relation to the equatorial lines, the true meridian would not at all times be indicated; and that to get close to the meridian we would have, first, to set on the pre-established meridian and determine the proper relation of the sun to the equatorial lines (the sun would in some instances be above and sometimes below its proper central position), and then work to this pre-determined position. We became satisfied that this difficulty arose from our inability to exactly adjust them.

From experience gained in these tests the writer became satisfied that much of the objection the profession has to the solar is due to the fact that additional adjustments are required, and that these adjustments are difficult to make, and their maintenance a matter of some uncertainty.

Believing that an instrument, from which are eliminated these difficulties, would be desirable, the writer began experiments to this end something over a year back, and the result of those experiments is now presented to you in a new solar transit; and I wish here to acknowledge my obligation to Messrs. Ulmer & Hoff, instrument makers, of Cleveland, O., for their care, patience and mechanical skill in the development and construction of this, the first instrument produced.

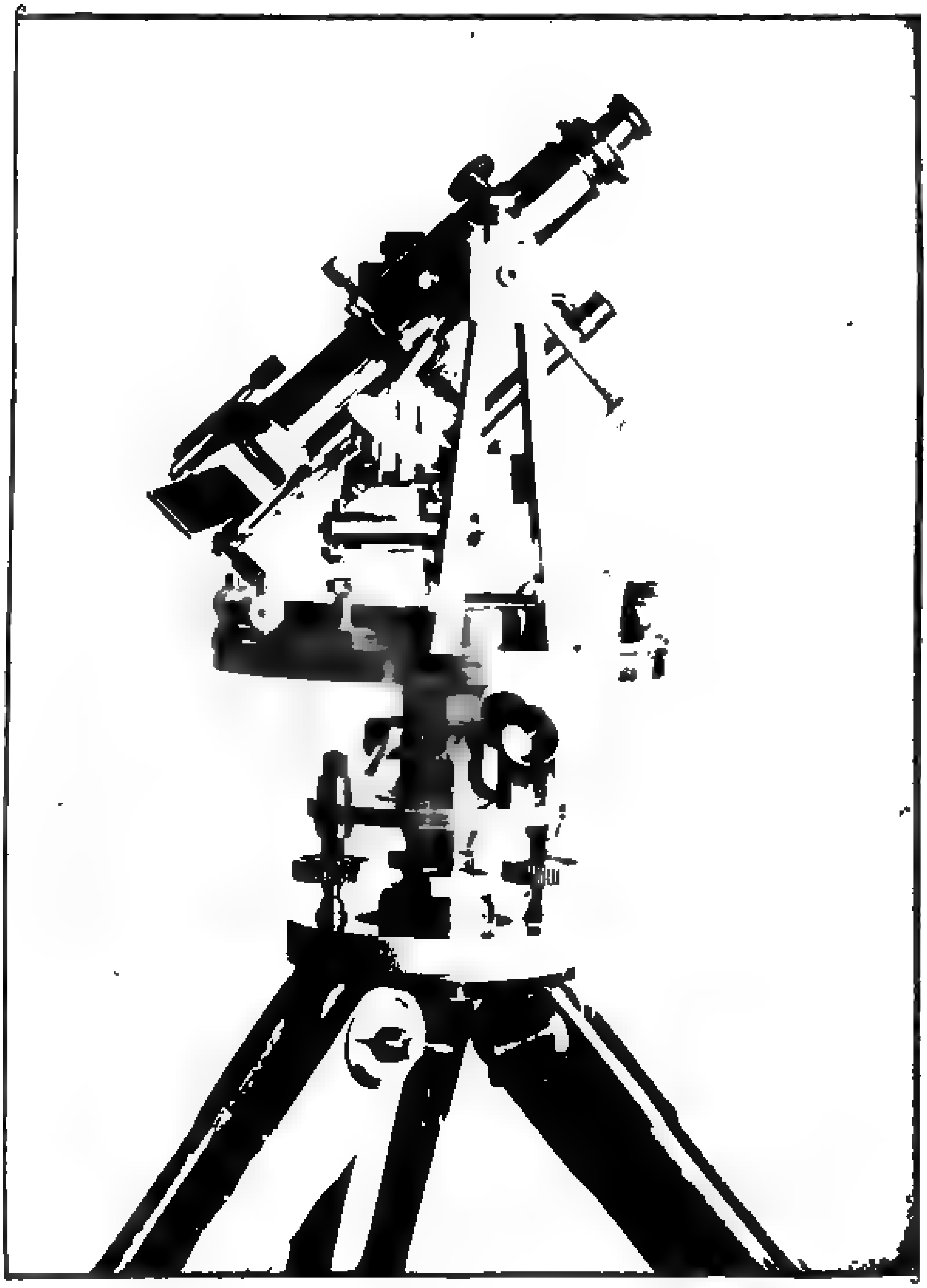
DESCRIPTION AND USE OF J. B. DAVIS' SOLAR TRANSIT.

(PATENT APPLIED FOR.)

In this instrument the transit telescope is used for solar work, thus obtaining increased accuracy on account of using a larger telescope; also by the method of setting the reflector, eliminating the maintenance of solar adjustments, thereby not only increasing the accuracy of the solar instrument, but the certainty of its indications as well, for the reason that solar adjustments are difficult to make, are sensitive and consequently easily disturbed. All solar transits heretofore constructed require the maintenance of certain adjustments additional to those of the engineer's and surveyor's transit.

The telescope has a fixed object end, and is constructively placed central, so that the line of collimation is adjusted on a fixed point by revolving telescope in its sleeve, and as line of collimation in this solar construction represents the polar axis, the reflector revolving with the telescope, there are no solar adjustments required to be maintained, as the reflector is placed in proper relative position each time a solar observation is made.

A telescope with a fixed object end, and a reflector attached thereto, and revolvable therewith, is used instead of revolving the solar reflector on the object end of the usual fixed transit telescope with object slide, for the following reasons:



A New Solar Transit.

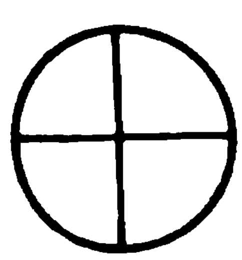
With telescope fixed in its axis and the reflector revolving, the bearing ring would then become the polar axis, and would be too short. A long polar axis is desirable.

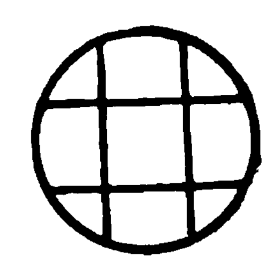
Adjustments would have to be provided to make the bearing ring concentric with the line of collimation.

Adjustments for the perpendicular position of the reflector plane would also have to be provided.

A fixed object end is a necessity, as even with the most perfect construction of object slide there would be play enough to make accurate solar work impossible.

At the eye piece end of telescope in this instrument is located the cross-hair ring, or diaphragm; this ring





is provided with the usual cross-hairs and also with four solar hairs the two sets are essential; the first for transit and level work, the latter for solar work, and to avoid confusion they are so arranged on the diaphragm that when one set is distinctly focused, the other cannot be seen in the field of view. At same end of telescope is placed a shaded glass slide for use when observing sun.

The instrumental operation of determining the true meridian and latitude is as follows:

First—All transit adjustments having been made, the transit centers are placed perpendicular by means of plate levels and telescope level. Next with telescope leveled, sight a target, placing its horizontal center line in the horizontal plane passing through the optical axis of the telescope. (See Fig. 1.)

Second—With the horizontal limb of transit set preferably at zero (as convenience only in reading the angle), the telescope is now sighted to a line T.2 as much to one side of the target center T.1 as the center of the telescope axis C.2 is back of the intersection of the reflector plane and optical axis of telescope at R.c. This is done for the purpose of allowing for parallax due to the distance between the reflector plane and the center of transit telescope. (If an object can be sighted which is in a horizontal plane with the optical axis of the telescope and at such distance

FIG. 1.

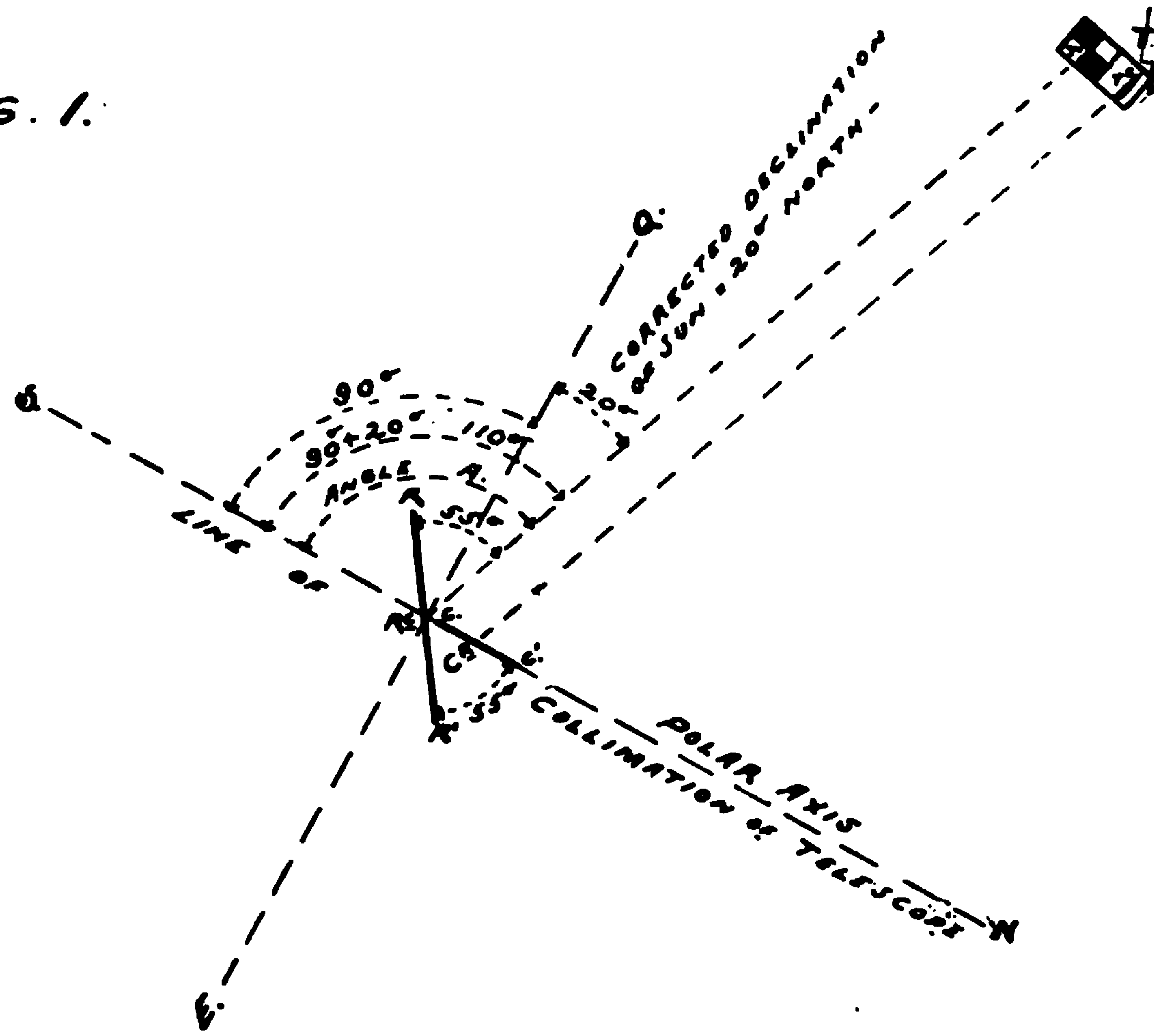


FIGURE 1—DESCRIPTIVE.

N-S—Line of collimation of telescope and polar axis.
E Q—Equator.
$C\ C^1$—Transit telescope.
$R\ R^1$—Reflector.
R^c —Position of image in reflector plane.
C^R --Center of Transit telescope.
T—Target. T^1 Centre of target.
T^2--Sighting line on target.
$R^c\ C^R = T^1\ T^2$

Optical axis of telescope C. $C.^1$, target center $T.^1$, and image of the same in reflector R. $R.^1$ are all in the same horizontal plane when target image is thrown into line of collimation.

NOTE—When the reflector is placed at an angle of 46° to the line of collimation, the line of sight of telescope is deflected 90°, and will represent the equator.

as to eliminate parallax, it may be sighted to direct.) Next turn the telescope by means of the horizontal limb, through an arc equal to 90 degrees plus or minus the corrected declination of the sun at time of observation, according as the sun is north or south of the equator.

Third—Level the transit telescope and place the reflector in such position, by means of its perpendicular adjustment screw and its tangent screw, as that the image of the target will appear exactly in the line of collimation of telescope; by this operation the plane of reflector is placed one way perpendicular to the optical axis of telescope, and at the same time at such horizontal angle thereto as the declination of the sun at time of observation requires.

Fourth—Having now placed the reflector at the proper angle, unclamp the outer center on which the instrument revolves horizontally; turn the object end of telescope south (preferably south to avoid the necessity of the use of a diagonal eye piece), place the central cross-hair out of focus and bring into focus the solar hairs, dip the telescope from a horizontal position by an angle equal to the latitude of place of observation by means of the vertical or latitude arc, and securely clamp it; loosen the set screw which passes through an arm of telescope axis and engages the telescope, so that telescope can be revolved in its sleeve; it will be seen that the sun can then be followed in its daily motion. Revolve the telescope in its sleeve, and at the same time the whole transit horizontally, until the sun appears exactly in the solar square formed by the intersection of the four solar hairs, when firmly clamp outer center; telescope will then be in the true meridian.

Fifth—Bring telescope back to its normal position in sleeve and secure it by set screw before referred to, unclamp telescope axis and fix the meridian line by suitable points. In doing this the reflector can be removed from object end of telescope; or unclamped and placed in line with telescope, as it in this position forms no obstruction whatever to the line of sight.

Latitude by instrument is determined by:

First—Placing reflector at proper angle (as in instructions

for finding the true meridian) to reflect the sun's image, when at noon declination, into the optical axis of telescope.

Second—Revolve telescope in sleeve until the vertical solar hairs have become horizontal.

Third—Dip telescope and follow sun until it has attained its greatest altitude, when read off latitude from vertical arc.

When transit is not required for solar work the reflector can be removed from the object end of telescope if desired and telescope secured in its normal position by the set screw; central cross-hairs are then vertical and telescope is firmly fixed in its sleeve.

In the description which follows, of the principle on which the operation of this solar is based, a sufficient knowledge of astronomy and of its application to solar work is presumed.

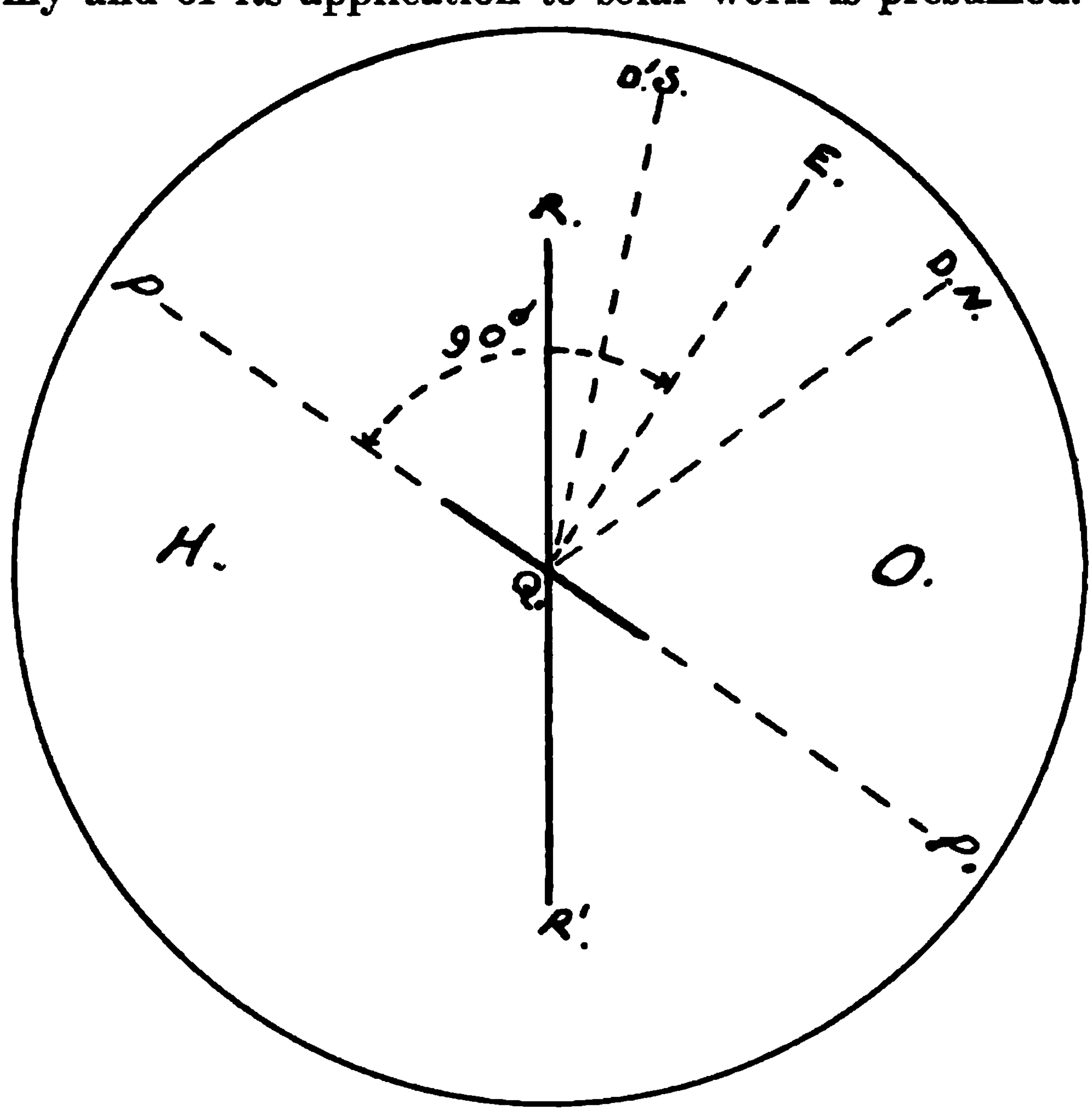


FIG. 2.

DESCRIPTIVE.

H. O.—Horizontal Plane.
P. P[1]—Line of collimation of transit.
R. R[1]—Reflector plane.
E. Q.—Line at right angles to line of collimation from point Q.
Q.—D. N. and Q.—D[1]. S.—Declination lines.

Place the line of collimation of transit telescope P. P. in the horizontal plane H.O., and intersecting a reflecting plane R.R1. at Q., so placed that any point E. situated in the horizontal plane and in a line at right angles to the line of collimation from the point Q. will be reflected into line of collimation; or in such other position that any point lying in the horizontal plane and situated either to the right or left of the point E. and in a line from point Q., making an angle with the line E. Q. equal to the declination of the sun at the time any of these points, such as D. N. and D1. S. are reflected into the line of collimation. Reflecting plane will then be perpendicular to the horizontal plane, and consequently at right angles to the line of collimation.

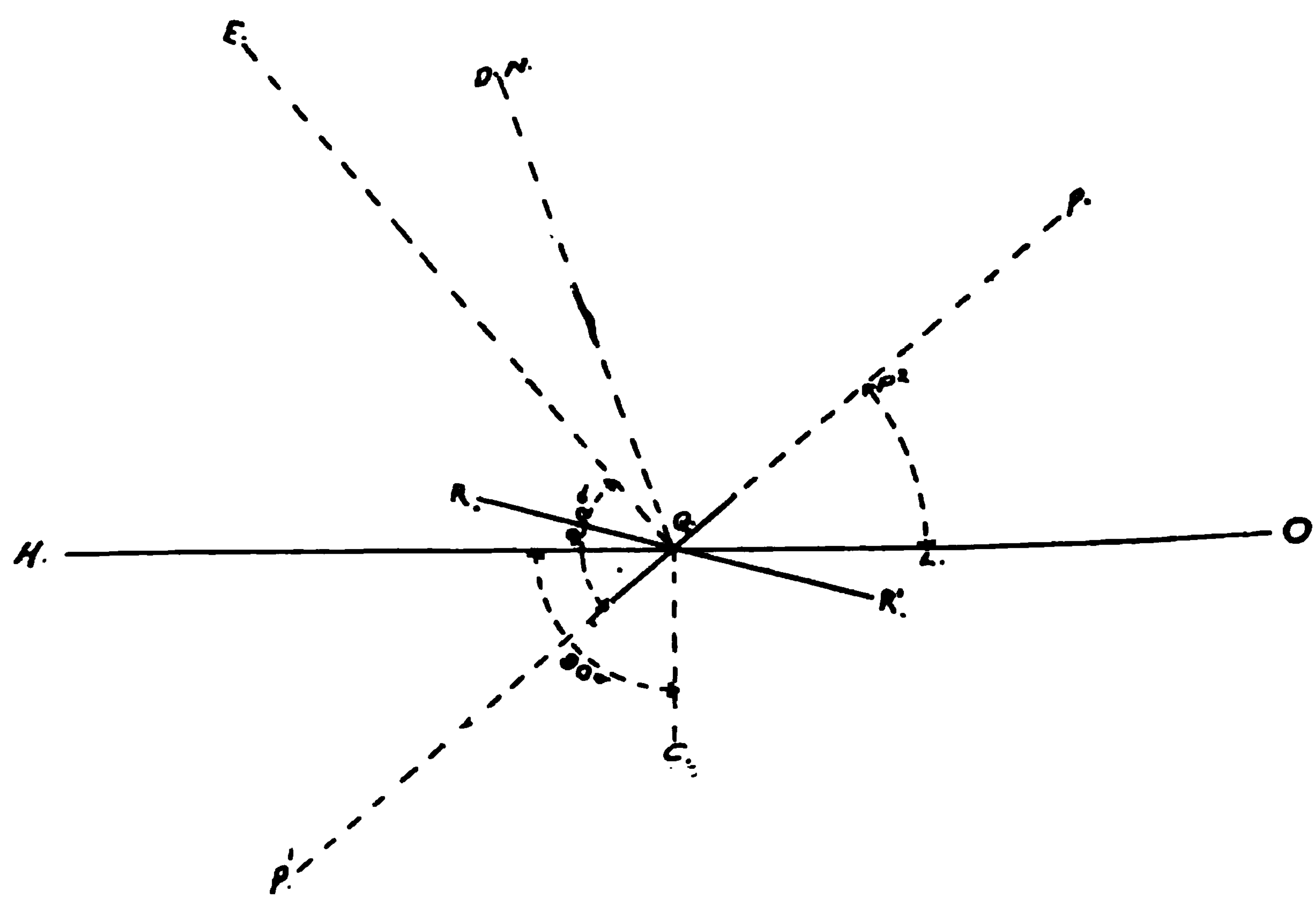


FIG 3.

Referring to Fig. 3, without disturbing the relative position of line of collimation and reflecting plane, incline the line of collimation P. P1. to the horizontal plane H. O. equal to the latitude of place P.2 L., giving to the reflecting plane a circular motion, having for its axis the line of collimation; by this motion the sun can be followed in its passage from east to west points of horizon.

Give the line of collimation a horizontal circular motion, the axis of this motion being in the line Q. C., which is at right angles to the horizontal plane, and at the same time revolving the line of collimation and with it the reflecting plane until the center of the image of the sun is seen exactly in the line of collimation.

The line of collimation will then be in the meridian plane of observer.

Again referring to Fig. 1, let it be understood that in the operation of this instrument the optical axis of telescope, or line of collimation is what is termed the polar axis in other solar instruments, so that a line perpendicular to the optical axis, from a point in the reflector plane at its intersection with the optical axis of telescope produced, will represent the equator, so that the sun in its position to one or the other side of the equator in its varied positions of declination throughout the year, will be represented by the correspondingly varied horizontal angular position of the target as sighted to in each observation; this varied position of the target with reference to the aforesaid equatorial line is determined by the angle A., which varies correspondingly with the sun's declination. It will thus be seen that the target bears the same relation to the optical axis of telescope and the aforesaid perpendicular line thereto, that the sun does to the polar axis and equatorial line, and that if the telescope be dipped with reference to a horizontal plane, sufficient to conform to the position of the earth's axis at point of observation, that the sun's image can only be seen in the optical axis of telescope when telescope has been brought into the plane of the meridian.

The advantages obtained in this solar transit are as follows:

The use of only one telescope.

The use of a large telescope for solar work.

Disposing of the usual declination arc.

Eliminating the maintenance of all adjustments of solar parts.

No counterpoising on account of the addition of solar parts, or attachments.

The writer is satisfied that solar work wherein the closest

results possible are required, can only be done in the middle of the forenoon or afternoon. Close work cannot be done and need not be attempted with any solar very near noon, as at this time an error in setting off the exact latitude or declination is considerably multiplied in the azimuth. A want of knowledge on this point has led many into error and some to doubt the efficacy of solar work entirely, under the wrong presumption that any hour of the day is equally favorable to solar work.

With this instrument solar work in keeping with the accuracy of an engineer's transit can be done if the proper hours of the day for doing it are selected.

DISCUSSION.

Mr. Gilpatrick—How long does it take to make observations?

Mr. Davis—If a person is doing accurate solar work, he should take more than one observation. The first observation is the one that takes the time, because that one requires that you get it absolutely perpendicular. After that the time is very limited. The first observation might take ten minutes, as you have to be very careful to get the axis perpendicular. After that it would perhaps not exceed five minutes. After that you can take an observation as quick as you can wait for the needle to settle.

Question—The sun changes and it might be too large one day or two small the next day.

Mr. Davis—I think you could make a better contact with the sun with the space above the line than by absolutely on the line.

Mr. Weddal—What are the chances of this instrument coming to where it will lose some of its usefulness?

Mr. Davis—That condition is not likely to come until your transit is worn out. It is a fair presumption that with the limited motion of this telescope it will last a great while.

Mr. Strawn—What is it worth?

Mr. Davis—It would not cost any more than any other instrument.

A TIMBER TRESTLE.

BY CHAS. A. JUDSON, SANDUSKY, OHIO.

Mr. Judson exhibited sketch. This is a trestle between Norwalk and Sandusky on the electric railroad. The road is about eighteen miles long and was constructed by local capital.

In the first place, they had no use for an engineer on the line, except to give the center lines and grades, and occasionally a curve that they could not master themselves, and one or two other things. The balance of the work was done by themselves.

The trestle that I show you was designed by a carpenter. The grade approaching the trestle is six per cent. at one end and seven per cent. at the other. The highest point is something like sixteen or eighteen feet high. The trestle is something like 600 or 700 feet long. The posts are 8x8 inches and the stringers 3x12 inches. The braces are about four feet from the end of the posts and are about 4x6 inches, and are placed into the posts about 12 feet from the top. As we approach the sides where the posts are shorter, the distance is lessened and the brace is much shorter, being an average of seven feet. The ties are 6x6 inches, of oak. The timber of the trestle itself is white pine.

The cars they have running over this road are about 40 feet long over all. They are vestibuled cars, with double motors, and weigh something like ten tons. By questioning the conductors, and from observations that I have made, they carry from 100 to 125 people at one time on those cars. The total weight of a car is something like sixteen or seventeen tons when fully loaded. A span being sixteen feet, and the trucks eighteen feet apart, you will readily see, by a simple calculation, that the stringers, being only 3x12 inches, and two of them under each rail, makes an equivalent of one piece 12x12 inches. That will only sustain one-third of that load. The wheels are only four feet apart on each truck, and figuring that as the center load—it is nearly the center load—but when you take into account that it is a moving load, it makes it practically correct. So that the braces are ex-

pected and must sustain a strain of 900 pounds to the square inch.

DISCUSSION.

Mr. Davis—One of the most serious objections is the fact of its having a standard gauge, and that it can connect with a steam road. It may be that it will connect with a steam road some time and haul much heavier loads over it than was intended.

Mr. Dunn—That structure reminds me very much of another structure that I once saw and of the remark that was made about it. A man of experience looked at it and said: "This looks very much to me as if some fellow had built it and designed it himself."

Mr. Layman—I think we ought to make a move towards the formulation of a law for the appointment of a proper railroad commission for the State of Ohio, founded on the Massachusetts law. The law in Massachusetts provides that one member of the railroad commission shall be a civil engineer in good standing. I thought it might be a good idea to refer this matter to a committee to report on at our next annual meeting. I move that a committee of three be appointed to report at the next annual meeting, such measure as in their judgment may be expedient for the passage of a law providing for a railroad commission in the State of Ohio, based upon the Massachusetts railroad commission law.

Motion seconded and carried.

NOTES ON A RECENT DRAINAGE DECISION.

BY E. B. OPDYCKE, PULASKI, O.

The Supreme Court of Ohio has finally placed itself on record as to the limits of the special taxing district and as to the correct principles for making assessments in drainage cases. The decisions of the lower courts rendered in the case of Blue et al. vs. Wentz et al. (from Wyandotte county), were reversed by the Supreme Court and the case was remanded to them for further proceedings. With less of friction the Supreme Court could have adopted the decision of the lower courts, but the Supreme court was not so averse to intellectual labor and careful investigation as to allow itself to be carried along with the current of decisions which are not in harmony with the principles of law and with broad public policy. The very fact that the decision of the Supreme Court was adverse to that of the lower courts on a simple question of right principle is an earnest that the higher court gave the question a more searching investigation and more careful review than was apparent in the decision made by the lower courts. The higher court drank deeper from the "Pierian spring," where—

"Shallow draughts intoxicate the brain
And drinking largely sobers us again."

Its decision is eminently logical and just. It is marked by strong common sense and settles a mooted question. It discards, once for all, an erroneous principle for making special assessments in drainage cases upon which much injustice has been obstinately or unwittingly dealt out. Its logic is incisive and irrefutable. The conclusions are natural deductions from simple principles which pointed to them by way of implication; and the decision likewise contains still more by implication than it expresses, but which some succeeding court connot consistently avoid developing when the questions arise before it. Finally, the decision shows us that when a momentous question is brought before the Supreme Court for solution, the court is generally to be found in the line of progress. An abstract of the decision is this:

1. "Where the lands of an owner, by reason of their situation, are provided with sufficient natural drainage, they are not liable for the cost and expense of a ditch necessary for the drainage of other lands, simply for the reason that the surface water of his lands naturally drain therefrom to and upon the lands requiring artificial drainage.

2. "A lower tenement is under a natural servitude to a higher one to receive from it all the surface water, accumulating from falling rains and melting snows, or from natural springs, that naturally flows from it to and upon the lower one. This advantage of the higher tenement is a part of the property of the owner in it, and he is not indebted to the lower owner therefor.

3. "In making an assessment on lands, benefited by artificial drainage, the extent of their watershed is not the proper rule, but the amount of surface water for which artificial drainage is required to make them cultivable, and the benefits that will accrue to the lands from such drainage. However much water may fall on them or arise from natural springs, if, by reason of their situation, they have adequate natural drainage therefor, they are not liable for the cost of artificial drainage to other lands."

REPORT OF COMMITTEE ON INSTRUMENTS AND EXHIBITS.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

While the display in this department is not as large as at some previous meetings, the exhibits without exception are highly meritorious.

The display made by L. M. Prince, No. 134 West Fourth street, Cincinnati, O., consisting of engineers' draughting tools, levels, transits, level rods, tables, etc., etc., was worthy of special mention.

A fine Wye level, manufactured by Ulmer & Hoff, Cleveland, O., occupied a conspicuous position among the exhibits; the instrument shows evidence of superior workmanship. The same firm also have on hand a fine display of steel tapes and reels.

L. Dennison, Columbus, O., exhibited his azimeter instrument, which is worthy of the careful consideration of the Society for its meritorious and novel features.

A unique and ingenious drafting table exhibited by the J. G. Alexander Manufacturing company, Grand Rapids, Mich., attracted much attention and admiration.

The Murray Jemeley Manufacturing company, Dayton, displayed a fine assortment of street names and house numbers.

The Alpha Portland Cement company has shown what can be done in the manufacture of curbing from Portland cement.

The International Correspondence School, Scranton, Pa., and the Engineering and Mining Journal, distributed literature among the members of the Society.

A new solar transit, the invention of J. B. Davis, Cleveland, and member of the Society, and used by the gentleman to illustrate a paper before the Society, while not classed as a part of the exhibits before the Society, yet deserves more than a passing notice. The unquestioned improvements over other solar attachments cannot help but secure for this instrument a front place in the ranks of the engineering profession.

The maps, photographs and blue prints exhibited by H. L. Weber, City Engineer of Richmond, Ind. were greatly admired by all.

Other valuable papers and maps by way of illustration were exhibited by members of the Society, who will pardon us if their names do not appear in connection therewith, as we failed to learn the names of all.

HOMER C. WHITE,
Member of the Committee.

SUGGESTIONS FOR IMPROVEMENT.

BY BENJAMIN THOMPSON, GREENSBORO, N. C.
(Secretery of the Society from 1882 to 1888.)

Greensboro, N. C., January 29, 1896.

Mr. C. A. Judson, Secretary Ohio Society Surveyors and Civil Engineers, Sandusky, O.:

Dear Sir—You kind invitation to be present at the annual meeting of the Society to be held in Dayton, O., at an early date, has been forwarded to me here. I appreciate it, as well as your complimentary remarks, but regret that I cannot be present. I am now in the employ of the Southern Railway company, and my time is almost wholly taken up, at least so far as going elsewhere than on its lines is concerned.

While I am not sure that I could prepare an article that would be of interest to the members of the Society, even if I had the time now to attempt to do so, yet I feel inclined to do anything I can to help make the meetings interesting, and believing that the suggestion I now make may help out, I present it for your consideration.

There is much idle thought. There are hours and days in nearly every man's existence in which the mind busies itself over this thing, that thing, nothing in particular. It will not be still and inactive. Waste is the result, and waste is abhorrent. Systematic control of its action, which any one can acquire, will replace this waste by that which will be of value.

With this as a preliminary, which I think will be admitted. I would suggest that the younger members especially—I am one of them—form themselves voluntarily into classes of perhaps three or four each, for the individual and mutual consideration of some branch of engineering, from one annual meeting of the Society to the next, with the intention of mastering, so far as they may be able, the principles and practice of that branch. Having agreed upon what works of reference each shall examine, as their studies proceed, let each propound to the others of his class questions and problems to be answered and solved, and authorities given. Let the members, at their con-

venience, meet during the year for mutual consideration and discussion of the subject of study, and of any special matter each member of the class mav have on hand. Let no one be ashamed to admit his ignorance, but be ashamed to have it continue.

It will take some effort to do this, but what of it? Is not the object to be attained worthy of it? Will not the mutual acquaintance, the confidence in and respect for the opinions of his fellows be of value? Will not each be more interested in the success of the others? Will not each be a better and broader-minded man, as well as better engineer, and more worthy of success? Will not the annual meetings of the Society be looked forward to with even more pleasure than at present?

It seems to me that by the encouragement, and perhaps by the direction and management, on the part of the Society, of a system of this kind, more or less elaborate, the influence of the Society and the worth of membership in it may be augmented. It becomes in a more complete sense what it now is, a practical school of great value and little cost.

Please remember me especially to my old-time friends. Wishing you a successful meeting, and with kind regards for all, I am

Yours truly,

BENJ. THOMPSON.

RESOLUTIONS ON THE DEATH OF A. A. GRAHAM.

Notice of the death of Mr. A. A. Graham, honorary member of the Society, was received just before the last meeting. On motion a committee of two, consisting of C. N. Brown and E. A. Kemmler, was appointed to prepare suitable resolutions.

The following report was made and unanimously adopted:

Dayton, O., February 27, 1896.

To the Ohio Society of Surveyors and Civil Engineers:

We, the committee to whom was referred the matter of appropriate resolutions on the death of A. A. Graham, an honorary member of this Society from Columbus, O., and who died at Albuquerque, N. M., on February 5, report as follows:

Whereas, God, in His wisdom, has removed from us our esteemed friend and fellow-member, A. A. Graham, causing an irreparable break in our numbers; therefore, be it

Resolved, That in the death of our honored and respected friend our Society has lost an efficient and valuable member and one whose absence is greatly felt by all.

Resolved, That we tender our sincere regrets and sympathy to his bereaved family, relatives and friends, and that this report be spread upon the minutes of our Society and a copy be transmitted to his family by the secretary.

C. N. BROWN,
E. A. KEMMLER,
Committee.

IT IS DESIRED to call the attention of our members to those who advertise in the pages of our Report. It is hoped that all members will patronize them if in need of anything in their respective lines. Let them see it pays to advertise with us.

See that they are promptly informed of lettings in your vicinity or furnished with any information at your command which may be of service to them. Advertisers are especially grateful for favors of this kind, and which are of so little trouble to the members.

They help our Society by advertising with us, and it is therefore only just that we should show them favors when possible.

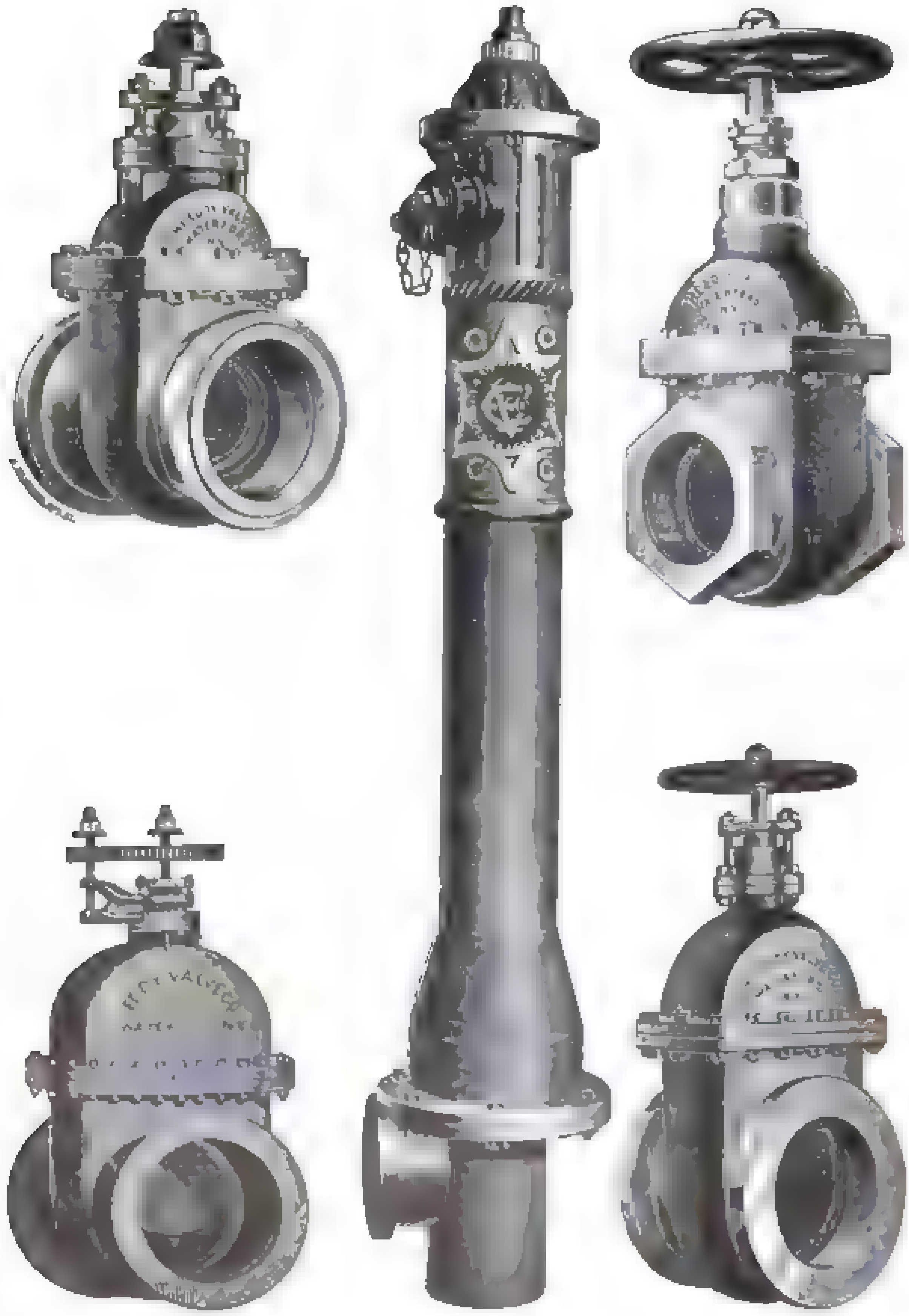
MEMBERSHIP.

HONORARY MEMBERS.

NAME.	BUSINESS.	RESIDENCE.
Frost, George H.	Manager Engineering News,	New York City, 154 Nassau St.
McFarland, R. W.,	Civil Engineer,,	Corning, Perry Co.
Mendenhall, T C ,	Pres. Worcester Polytechnic Inst.,	Worcester, Mass.
Orton, Edward,	Professor in Ohio State University,	Columbus, Ohio.
Thompson, Benj.,	Civil Engineer,	Chattanooga, Tenn.

THE EDDY VALVE CO.

Waterford, N. Y.



ACTIVE MEMBERS.

NAME.	BUSINESS.	RESIDENCE.
Abernethy, C. F.,	County Surveyor,	Circleville, Pickaway Co.
Alkire, H. F.,	Deputy County Surveyor,	Woodlyn, Pickaway Co.
Amsden, Lewis A.,	Surveyor and Civil Engineer,	Ashtabula, Ashtabula Co.
Arnett J.,	Surveyor and Civil Engineer,	London, Madison Co.
Atkinson, J. W.,	Sup't of Roads and Ass't Engineer N. P. & O. R. R.	Galion, Crawford Co.
Bachtell, Samuel,	Assistant U. S. Engineer,	Columbus, Franklin Co.
Baker, Samuel J.,	County Surveyor,	Cleveland, Cuyahoga Co.
Bartholomew, Geo. W., Jr.,	Treasurer Buckeye Cement Co.,	Bellefontaine, Ohio.
Bliss, A. L ,	Surveyor and Civil Engineer,	Northfield, Summit Co.
Boalt, Eugene E.,	Ass't Eng'r in Charge of Sewers,	Cleveland, Cuyahoga Co.
Boggs, Edward M.,	Prof. Hydraulic and Civil Engineering, Univ. of Arizona,	Tucson, Arizona.
Bone, Frank A,.	Civil Engineer and Surveyor,	Lebanon, Warren Co.
Bowen, B. F.,	Surveyor and Civil Engineer,	Columbus, Franklin Co., 23 East State Street.
Brown, C. N.,	Professor Civil Engineering, Ohio State University.	Columbus, Franklin Co.
Brown, Fred W., E. M.,	Chemist and Secretary of Buckeye Cement Co.	Bellefontaine, Logan Co,

ACTIVE MEMBERS—Continued.

NAME.	BUSINESS.	RESIDENCE.
Brown, J. R. C.,	City Civil Engineer,	Ironton, Lawrence Co.
Brown, Jay F.,	Surveyor and Civil Engineer	Cleveland, Cuyahoga Co., 205 Cuyahoga Building.
Bryan, R. A.,	Civil Engineer,	Portsmouth, Scioto Co.
Buck, John T.,	Surveyor and Civil Engineer,	Cardington, Morrow Co.
Burgess, C. H.,	Civil Engineer and Contractor,	Cleveland, Cuyahoga Co., 89 Euclid Avenue.
Cellarius, F. J.,	Assistant City Engineer,	Dayton, Montgomery Co., Room 8, City Building.
Chapin, Loomis E.,	City Civil Engineer,	Canton, Stark Co.
Clark, J. H.,	Civil Engineer,	Loudonville, Ashland Co.
Connar, T. C.,	Civil Engineer,	Zanesville, Muskingum Co.
Cook, Louis H.,	Village Engineer,	Brooklyn Village, Cuyahoga Co.
Courtright, John,	Civil Engineer and Surveyor,	Columbus, Franklin Co., 276½ South High Street.
Craig, Samuel	County Surveyor and Engineer,	Wapakoneta, Auglaize Co.
Cronley, J. C.,	County Surveyor,	Lima, Allen Co.
Davis, John B.,	Civil Eng'r and Land Surveyor,	Cleveland, Cuyahoga Co., 29 Euclid Avenue, Room 1.
Davis, C. S.,	Chief Eng. Massillon Bridge Co.,	Toledo, Lucas Co.

ACTIVE MEMBERS—Continued.

NAME.	BUSINESS.	RESIDENCE.
Davisson, F. M.,	Surveyor and Civil Engineer,	West Manchester, Preble Co.
Denison, L. B.,	Civil Engineer,	Columbus, Franklin Co.
DeWitt, Chas. E.,	County Surveyor,	Port Clinton, Ottawa Co.
Dillon, L. A.,	City Civil Engineer,	Hamilton, Butler Co.
Doyle, P. H.,	Civil Engineer,	Columbus, Franklin Co.
Dunn, Wm.,	County Surveyor and Civil Engineer,	Zanesville, Muskingum Co.
Egerton, J. T.,	County Surveyor and Engineer,	Ironton, Lawrence Co.
Evers, Wm. H.,	Deputy County Surveyor,	Cleveland, Cuyahoga County, 91 Chatham Street.
Fauver, L. A.,	Surveyor and Civil Engineer,	Lorain, Lorain Co.
Fox, Herman S.,	County Surveyor,	Dayton, Montgomery Co.
Gates, Harry M.,	Civil Engineer,	Columbus, Franklin Co., 25½ N High Street
Gayer, Wm. Carl,	Civil Engineer,	Akron, Summit Co.
Gerrish, W. B.,	Sup't Water Works and City Eng'r,	Oberlin, Lorain Co.
Giessen, Charles S.,	Surveyor and Civil Engineer,	Cleveland, Cuyahoga Co., Room 302 City Hall.
Gilpatrick, Jno. L.,	Prof. Mathematics, Civil Engineer'g and Astronomy, Denison Univ.	Granville, Licking Co.
Gotwald, Robert C.	Civil Engineer,	Springfield, Clarke Co.

ACTIVE MEMBERS—Continued.

NAME.	BUSINESS.	RESIDENCE.
Grim, John C.,	Civil Engineer and Surveyor,	Bryan, Williams Co.
Gyger, George R.,	City Civil Engineer,	Alliance, Stark Co
Hanlon, J. A.,	Civil Engineer,	Coshocton, Coshocton Co.
Hanlon, Wm. B.,	Chf. Eng. C. L. & W. R R Co., Min. Eng. Pitts. & Wheel'ng Coal Co.	N. Philadelphia, Tuscarawas Co.
Harper, J M.,	Civil Engineer,	Cincinnati, Hamilton Co., Richelieu Building.
Harvey, E E.,	Surveyor and Civil Engineer,	London, Madison Co,
Haseltine, Edwin D.,	Civil and Mining Engineer,	Youngstown, Mahoning Co.
Hill, George H.,	Civil Engineer and Surveyor,	Milford, Clermont Co.
Hill, H. J ,	County Surveyor,	Marion, Marion Co.
Hoover, Oliver H ,	Deputy County Surveyor,	N. Philadelphia, Tuscarawas Co.
Howe, C. S., Ph D.,	Prof. Math. and Astronomy, Case School of Applied Science.	Cleveland, Cuyahoga Co.
Huston, Samuel,	County Surveyor,	Steubenville, Jefferson Co., 601 North Fifth Street.
Innis, Gustavus S.,	Surveyor and Civil Engineer,	Columbus, Franklin Co., 176½ South High Street.
Judson, Chas. A.,	Superintendent of Water Works,	Sandusky, Erie Co.
Kemmler, Edw. A.,	Assistant City Civil Engineer,	Columbus, Franklin Co.

ACTIVE MEMBERS—Continued.

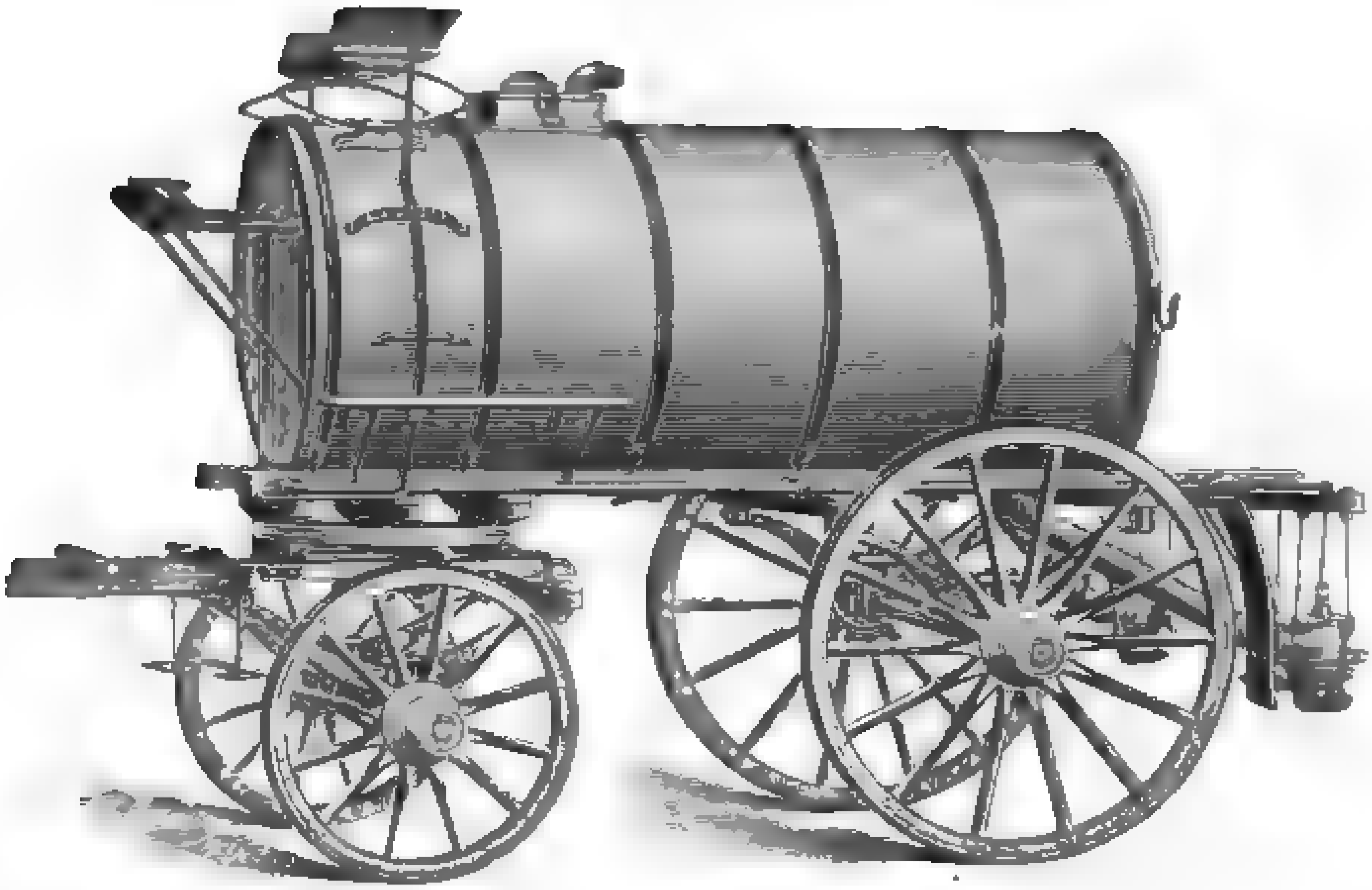
NAME.	BUSINESS	RESIDENCE.
Kinnear, Josiah,	City Civil Engineer,	Columbus, Franklin Co., 652 East Long Street.
Kearfott, Wm. D.,	Manager for H. R. Worthington,	Cleveland, Ohio.
Kline, Robert E.,	County Surveyor,	Dayton, Montgomery Co.
Krause, Frank Bernard,	Civil Engineer and Surveyor—Specialties: Driving Parks, etc.	Cleveland, Cuyahoga Co., 238 Soc. for Sav. Bldg.
Lane, Edward G.,	Chief Engineer Valley Railroad,	Cleveland, Cuyahoga Co., 68 Wade Building.
Lander, Frank R.,	County Draftsman,	Cleveland, Cuyahoga Co., 932 Logan Avenue.
Laylin, John,	City Engineer and County Surveyor,	Norwalk, Huron Co.
Layman, E. F.,	Civil Engineer, General Practice,	Cincinnati, Hamilton Co., 64 W. Third Street.
Lee, R. H.,	Chief Engineer, East Central Railroad,	Carrollton, Carroll Co.
Lewis, Harry J.,	Civil Engineer, General Practice,	Pittsburgh, Pa., Times Bl'g.
Lillie, F. M.,	City Civil Engineer,	Youngstown, Mahoning Co.
Loomis, Elisha S.,	Civil Engineer,	Berea, Cuyahoga Co.
Lutz, Martin,	Civil Engineer,	Celina, Mercer Co.
Mackey, Charles L.,	Surveyor,	Youngstown, Mahoning Co.
McKay, G. A.,	County Surveyor and Civil Engineer,	Xenia, Greene Co.

ACTIVE MEMBERS—Continued.

NAME.	BUSINESS.	RESIDENCE.
Mann, H. E.,	City Civil Engineer,	Ashtabula, Ashtabula Co.
Marble, Reuben R.,	Civil Engineer,	Columbus, Franklin Co.
Markley, Philip,	County Surveyor and Civil Engineer,	Wooster, Wayne Co.
McCafferty, H. L.,	County Surveyor and Civil Engineer,	London, Madison Co.
McGormley, Geo. W.,	With Massillon Bridge Company,	Toledo, Lucas Co.
McDonald, H. W.,	Sanitary Engineer,	Galion, Crawford Co.
Merchant, C. C.,	Surveyor,	Cleveland, Cuyahoga Co.
Morgan, Arthur L.,	Ass't Eng. M. of W. C. & M. V. Ry.	Zanesville, Muskingum Co.
Muchlenbeck, C. F. W.	Village Engineer,	South Brooklyn.
Myers, W. E.,	Professor of Civil Engineering, Ohio Normal University.	Ada, Hardin Co.
Newberry, Spencer B.,	Manager and Chemist, Sandusky Portland Cement Company.	Sandusky, Erie Co.
Nicholson, George B.,	Chief Engineer, Queen & Crescent Route,	Cincinnati, Hamilton Co., N. W. cor. 7th and Elm Sts.
Niederheiser, F. L.,	County Surveyor and City Civil Engineer,	Ashland, Ashland Co.
Opdycke, E. B.,	Civil Engineer and Surveyor,	Pulaski, Williams Co.
Payne, John W.,	Assistant City Civil Engineer,	Akron, Summit Co.

ACTIVE MEMBERS—Continued.

NAME.	BUSINESS.	RESIDENCE.
Pfouts, O. W.,	Assistant City Civil Engineer,	Canton, Stark Co., Box 110
Pugh, A. G.,	Contractor,	Columbus, Franklin Co., 148 North High Street.
Paul, Hosea,	Assistant Engineer, Park Department,	Cleveland, Cuyahoga Co., 76 Euclid Avenue.
Rock, S. F.,	Editor "The Climax,"	Richmond, Kentucky.
Root, Chas. W.,	Assistant County Draftsman,	Cleveland, Cuyahoga Co.
Russell, W. G.,	County Surveyor and Civil Engineer,	Russell, Russell Co., Kan.
Scott, J. W.,	Civfl Engineer and County Surveyor,	Marion, Marion Co.
Seitz, D. W.	County Surveyor and Civil Engineer,	Ottawa, Putnam Co.
Sharon, William,	County Surveyor	Springfietd, Clarke Co.
Sheldon, A. D.,	Surveyor and Civil Engineer,	Whittlesey, Medina Co.
Sill, John S.,	Surveyor and Civil Engineer,	Ashtabula, Ashtabula Co.
Smith, Edwin A.,	Civil Engineer,	Norwalk, Huron Co.
Snow, C. H.,	City Civil Engineer,	Elyria, Lorain Co.
Snyder, Frank,	Hydraulic and Sanitary Engineer,	Columbus, Franklin County, Room 18, 28 E. State St
Spafford, E. L.,	Surveyor and Civil Engineer,	Bowling Green, Wood Co.




CITY GARBAGE WAGON.

ACTIVE MEMBERS—Concluded.

NAME.	BUSINESS.	RESIDENCE.
Stattelmann, G. R.,	Civil Engineer,	Dayton, Montgomeey Co., 37 Washington Street.
Strawn, J. B.,	Civil and Sanitary Engineer, Con. Eng. Water Works and Electric Light.	Salem, Columbiana Co.
Strehler, Alfred,	Assistant City Civil Engineer,	Cleveland, Cuyahoga Co.
Taylor, George,	County Surveyor,	Lima, Allen Co.
Turner, F. M.,	City Civil Engineer,	Dayton, Montgomery Co.
Vance, Charles F.,	Civil Engineer and Contractor,	Troy, Miami Co.
Varney, J. D.,	Civil Engineer and Surveyor,	Cleveland, Cuyahoga Co., 58 Public Square.
Walker, R. F.,	Civil Engineer and County Surveyor,	Troy, Miami Co.
Walker, B. H.,	Surveyor,	Chillicothe, Ross Co.
Weber, Harry L.,	City Civil Engineer,	Richmond, Indiana.
Weddell, John B.,	Civil Engineer,	Mansfield, Richland Co.
White, Homer C.,	City Civil Engineer,	Warren, Trumbull Co.
Wileman, E. D.,	Signal Engineer, L. S. & M. S. Railway,	Toledo, Lucas Co.
Wise, David M.,	Civil and Mining Engineer and County Surveyor.	Youngstown, Mahoning Co.
Wonders, Jas. C.,	City Civil Engineer.	Bellefontaine, Logan Co.

ASSOCIATE MEMBERS.

NAME.	BUSINESS.	RESIDENCE.
Beckman, Louis,	Manufacturer of Eng. and Surv. Instruments.	Toledo, Lucas Co.
Dannheiser, Jos. M.,	With L. M. Prince,	Cincinnati, Hamilton Co.
Johnson, Chas. L.,	With Alpha Portland Cement Company,	Chicago, Illinois.
Lucke, Chas. E.,	Manager of St. Louis Branch Keuffel & Esser Company.	St. Louis, Mo., 708 Locust Street.

EIGHTEENTH ANNUAL REPORT

OF THE

OHIO SOCIETY

OF

SURVEYORS AND CIVIL ENGINEERS

BEING THE

TRANSACTIONS OF THE SOCIETY

AT ITS

EIGHTEENTH ANNUAL MEETING

HELD IN

COLUMBUS, OHIO, JANUARY 18, 19 AND 20, 1897

PRICE, 50 CENTS.

COLUMBUS, OHIO
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1897

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OFFICERS, 1897.

President,
G. S. INNIS, COLUMBUS.

Vice-President,
F. J. CELLARIUS, DAYTON.

Secretary-Treasurer,
C. N. BROWN, COLUMBUS.

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1897-8.

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Robt. E. Kline, Dayton. John T. Buck, Cardington.
Philip Markley, Wooster. Henry Maetzel, Columbus.

LAND DRAINAGE.

D. W. Seitz, *Chairman*, Ottawa.

John Courtright, Columbus. H. J. Hill, Marion.
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W. B. Gerrish, Oberlin. Wm. D. Kearfott, Cleveland.
C. A. Judson, Sandusky. Frank Snyder, Columbus.

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E. A. Kemmler, Columbus. F. M. Turner, Dayton.

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John W. Stump, Circleville. J. T. Egerton, Ironton.
G. A. McKay, Xenia. H. E. Mann, Ashtabula.

CITY ENGINEERING.

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Hosea Paul, Cleveland. C. H. Snow, Elyria.
L. A. Dillon, Hamilton. H. L. Weber, Richmond, Ind.

BRIDGE ENGINEERING.

Harry J. Lewis, *Chairman*, Pittsburg, Pa.

C. S. Davis, Toledo. James C. Wonders, Bellefontaine.
G. R. Stattelman, Dayton. C. S. Howe, Cleveland.

LEGISLATION.

E. F. LAYMAN, *Chairman*, Cincinnati.

F. J. CELLARIUS, Dayton.
JOHN L. GILPATRICK, Granville.
L. B. DENNISON, Delaware.
B. H. WALKER, Chillicothe.

INSTRUMENTS AND EXHIBITS.

J. C. CRONLEY, *Chairman*, Lima.

WM. DUNN, Zanesville.
M. A. MUNN, Mansfield.
E. A. SMITH, Norwalk.
E. E. HARVEY, London.

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EIGHTEENTH ANNUAL REPORT

OF THE

OHIO SOCIETY

OF

SURVEYORS AND CIVIL ENGINEERS

Meetings Held in the Y. M. C. A. Building, Columbus, Ohio.

OUTLINE OF PROCEEDINGS.

MONDAY, JANUARY 18, 1897.

EVENING SESSION.

At the appointed time the Society was called to order by the Secretary, who stated that both the President and Vice President were absent. The Society then selected Mr. J. B. Strawn, of Salem, as Chairman.

The annual report of the Secretary was presented, and, upon motion, was received and ordered filed.

The annual report of the Treasurer was presented, and was by motion referred to the Board of Trustees for examination.

On motion, the reading of the report of the Trustees was passed and they were given further time in which to submit it.

Several applications for membership were, by motion, referred to the Board of Trustees.

President Davis, being unavoidably absent, had sent his address to the Secretary, who now read it to the Society.

After a short discussion of some of the points mentioned in the address, the Society adjourned.

TUESDAY, JANUARY 19, 1897.

MORNING SESSION.

The Society was called to order by the Secretary and Mr. J. B. Strawn chosen to preside for all of the remaining sessions of the meeting.

The report of the Committee on Civil Engineering was presented by the Chairman, Professor John L. Gilpatrick.

Papers were read and discussed as follows: "The Work of the County Engineer," by J. C. Cronley; "The Floor System of Highway Bridges," by C. S. Davis; "Strict Integrity a Necessary Qualification for the Engineer," by J. B. Strawn, and "Some of the Benefits of Our Society," by E. B. Opdycke (read by the Secretary, Mr. Opdycke being absent).

The report of the Committee on Legislation was postponed on account of the absence of the Chairman.

After a discussion of the recommendations made in the report of the Secretary it was moved, seconded and carried "that the dues for 1897 be placed at three dollars, with an initiation fee of two dollars for new members."

AFTERNOON SESSION.

Papers were read and discussed as follows: "Section Lines and County Boundaries," by Professor R. W. McFarland; "The Torrens Law," by Hosea Paul; "Re-locating the Lost Corner of Four Townships and Other Lost Corners," by G. S. Innis; "Sewage Disposal," by Dr. C. O. Probst, secretary State Board of Health.

The report of the Committee on Land Surveying and Drainage was presented by Mr. Homer C. White, chairman.

Mr. Jonathan Arnett was detained by sickness and could not send his paper in time for the meeting, but has sent it later so that it can be published.

The following committee was appointed by the chair, in the absence of the Trustees, to examine and report upon the Treasurer's books and the applications for membership, viz: C. A. Judson, John L. Gilpatrick, G. S. Innis.

Adjourned.

EVENING SESSION.

Mr. Haseltine's paper was postponed until the next session and the report of the Committee on Hydraulic and Sanitary Engineering was presented by Mr. C. A. Judson, chairman.

Mr. H. L. Weber's paper on "Obstacles Overcome in Sewer Construction," was read by the Secretary.

Mr. W. C. Parmley's paper on "Earth Pressure" was read by title and ordered printed, Mr. Parmley not being present.

A paper on "Lateral Sewers" was read by Mr. H. W. McDonald and afterwards discussed.

The chairman of the Special Committee on Railroad Commission not being present, the report was passed and the committee was continued and ordered to report next year.

The report of the Committee on Legislation was taken up, read and thoroughly discussed.

The chair appointed as Committee on Nominations the following members, viz: Homer C. White, J. A. Hanlon and Sam Huston.

Adjourned.

WEDNESDAY, JANUARY 20, 1897.

MORNING SESSION.

Meeting opened with Mr. Hosea Paul in the chair during the temporary absence of Chairman Strawn.

The report of the Committee on Railroad Construction and Maintenance was presented by John A. Hanlon, chairman.

Mr. Hanlon also read a paper on a related subject, "The Topographer in Railway Location."

A paper entitled "A Few Things English" was read by Mr. E. D. Haseltine.

Mr. Sam Huston read a paper on "Jefferson County Turnpikes," which was fully discussed.

A paper on "The Street Pavements of Elyria" was read by Mr. C. H. Snow, and brought out a full discussion of the subject of street pavements.

The papers not present for reading were ordered printed if they were sent to the Secretary in time.

The committee appointed to examine the books of the Treasurer and to report upon the applications for membership presented their report, which was, by motion, received and ordered placed on file.

The following named persons, having been recommended by the above committee, were then duly elected to membership by ballot, viz: John W. Stump, Seymore Rennick, Arthur L. Williston, Mortimer A. Munn, Edward S. Ault, Henry Maetzel, E. S. Jackson, J. W. Dowler.

Mr. R. M. Haseltine, Secretary of the Ohio Institute of Mining Engineers, was present and extended a most cordial invitation to the Society to attend and take part in the meetings of the Institute, to be held in the same room immediately after our adjournment, and to accompany them on Friday on a complimentary trip to the coal mines.

A vote of thanks was given the Institute for its very kind invitation and quite a number of the members availed themselves of it.

AFTERNOON SESSION.

Mr. S. B. Newberry read a paper on "Standard Sand for Cement Testing," and Mr. George W. Bartholomew read one on "Cement Culverts," which were followed by a general discussion of cement and its uses.

Mr. H. M. Gates, chairman of the Committee on Instruments and Exhibits, presented a report.

The Committee on Nominations presented list of officers, which was duly elected by ballot. The list is printed on page two of this report.

It was ordered, by motion, that the Legislative Committee prepare and report to the Society at its next meeting a draft of a bill on the matter of licensing surveyors.

A vote of thanks was tendered the press of Columbus for the careful reports they have made of the meetings.

On motion the eighteenth annual meeting was declared adjourned.

REPORT OF SECRETARY.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—I have the honor of submitting the following report of the Secretary:

The roll of membership is made up of:

Honorary Members	5
Active Members	121
Associate Members	4

Of the 125 members who are expected to pay dues only 47 have paid up to date, or only a few over one-third of the total number.

Of those delinquent 20 owe for one year and 19 owe for two years, the remainder owing for three or more years. Of those only one or two years behind quite a number will probably pay up during the coming year, of those farther behind there can be but little hope under our present dues.

This brings me to a matter that has been considered very carefully during the past year, and about which several of our members have been consulted, and that is the amount of our dues. During the past five years they have been $5.00 per year, and previous to that time they had been $3.00 per year. It is believed that the present rate is too high and that this is one of the main reasons for the withdrawal and dropping of so many of our older members. We all know that times have been very close for some years, and that surveyors and engineers have felt this with all other kinds of business.

I would, therefore, recommend that the annual dues be placed at the old figure of $3.00 per year, and that the membership fee be made $2.00. I hope that these figures may be still further reduced in the future.

I would also recommend that no allowance be made for the Secretary and Treasurer in the way of a salary.

Exchanges have been made as follows, and have been or soon will be distributed to the members:

Illinois Society of Engineers and Surveyors..........	1896
Michigan Engineers' Annual......................	1896
Engineering Association of the South...............	Vol. 7
Association of Ontario Land Surveyors...............	1896
The Technograph	No. 9
The Technograph	No. 10
The Technic	1896
Connecticut Civil Engineers' and Surveyors Association.	1896
Indiana Engineering Society......................	1896
Purdue Society of Civil Engineering................	1896

A somewhat new plan of distributing our reports and exchanges has been used for the past year, and the Secretary would be glad for an expression of opinion of it by the Society at this meeting. The reports and exchanges have been sent out one or two at a time by mail instead of in one large package by express, the idea being that a member receiving one or two at a time will be much more likely to read them than if he should get eight or ten at once, and also he is kept reminded of the existence of the Society and its objects. The new way is somewhat more expensive, but it is believed that the benefits warrant it.

The Secretary could not devote sufficient time to the Society work to secure advertisements for the report and papers for this meeting, and has been compelled to employ a clerk, at times, to do the correspondence. In order to secure the advertisements in the report over five hundred letters were written, and the program required nearly two hundred more. Letters, enclosing blank applications, have been written to all county surveyors and many city engineers inviting them to attend this meeting and to become members of the Society.

The mailing of the reports and this large correspondence accounts for the large item of postage in the Treasurer's report.

The dues paid in and the advertisements in the report have paid all bills against the Society except one of $66.05, which is the balance due the printer on the 1895 report, and which will be paid soon after this meeting. It is hoped that next year may see the Society entirely clear of debt.

Very respectfully submitted,

C. N. BROWN, Secretary.

REPORT OF TREASURER.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—I have the honor of submitting the following report of the receipts and expenditures of the Society for the society year of 1896, from February 21, 1896, to January 15, 1897.

The Treasurer for 1895, Mr. C. A. Judson, kindly closed up the business connected with the publication and distribution of the Sixteenth Annual Report, 1895, and makes the following statement of his receipts and expenditures:

RECEIPTS.

Balance on hand as per Annual Report, Feb. 21, 1896	$110 86	
By error in day book	9 00	
Sale of Annual Reports	2 50	
Membership Fees	6 00	
Dues for 1893	5 00	
Dues for 1894	10 00	
Dues for 1895	25 00	
Dues for 1896	37 00	
Advertisements, Fifteenth Report	3 00	
Advertisements, Sixteenth Report	90 00	$298 36

EXPENDITURES.

Printing Sixteenth Annual Report, on account	$155 00	
Stationery and Printing	8 75	
Expressage on sending out Reports, etc.	26 85	
Boxing Society Reports and freight to C. N. Brown	22 05	
Allowance to Secretary for 1895	80 00	$292 65
Cash turned over to C. N. Brown		$ 5 71

RECEIPTS AND EXPENDITURES BY C. N. BROWN.

RECEIPTS.

Balance from C. A. Judson	$ 5 71	
Sale of Reports	17 30	
Membership Fees	6 00	
Dues, 1894	5 00	
Dues, 1895	20 00	
Dues, 1896	198 00	
Advertisements, Sixteenth Report	5 00	
Advertisements, Seventeenth Report	212 00	$469 01

EXPENDITURES.

Printing Seventeenth Annual Report, total amount....	$229 56	
Printing circulars, letterheads, envelopes, etc...	22 12	
Stenographer Dayton Meeting	46 00	
Expressage and hauling	12 51	
Postage......	65 70	
Clerical help..........................	48 00	
Office supplies	2 15—	$426 04
Balance, cash on hand..................		$ 42 97

UNPAID ACCOUNTS.

Printing of Sixteenth Report..................................$ 66 05

ADDITIONAL RESOURCES.

From Advertisements in Seventeenth Annual Report............$15 50
Dues—an uncertain quantity.

Respectfully submitted,

C. N. BROWN, Treasurer.

REPORT OF AUDITING COMMITTEE.

(In place of Trustees, who were not present.)

The committee to whom was referred the report of the Treasurer report that they have examined the books of the Treasurer and find footings correct and proper vouchers for money paid out and the balance reported agreeing with the balance shown on the books.

The committee also report recommending the following persons for membership of this society, viz: J. W. Stump, S. Rennick, A. L. Williston, M. A. Munn, E. S. Ault, H. Maetzel, E. S. Jackson, J. W. Dowler.

Respectfully submitted,

G. S. INNIS,
C. A. JUDSON,
J. L. GILPATRICK,
Committee.

PRESIDENT'S ANNUAL ADDRESS.

J. B. DAVIS, CLEVELAND.

Gentlemen of the Ohio Society of Surveyors and Civil Engineers:

I find at this late hour that I shall not be able to meet with you at Columbus. I leave the city Monday to be absent the entire week on a matter that will admit of no postponement. I regret this very much, as it would have been profitable as well as a pleasure for me to have been with you.

As the time before the meeting is so limited it will be impossible for me to prepare for you any extended annual address. I will, therefore, touch briefly on only one point—that of legislation in the direction of licensing land surveyors. This is a subject that has now been before the Society for some time in various forms, and efforts have been repeatedly made to secure such legislation, and you well know with what success. Without going much into detail as to the probable causes of such failure, I will say that the bills so far presented have had on the face of them the too apparent self-interest of the surveyor, and while the argument has been used that the bills were entirely for the protection of the public against incompetent surveyors, our legislators and the public have not been able to so read them. In the drafting of these bills the idea has prevailed that there is only one class of surveyors that should be shut out from practice, that is the incompetent one; in our eager pursuit of this class the dishonest one has been passed by and lost sight of.

If it is desirable to exclude from practice the incompetent surveyor it is at least equally important that the dishonest one, who may be competent, should be excluded. And right here I will ask the question, would it not be better instead of asking for legislation to license surveyors—which seems very difficult, if not impossible to get—to ask for legislation that will in a measure fix the standard of surveys and let the surveyor's competency or honesty be measured by his ability and disposition to work up to such standard?

We have had very little legislation bearing directly upon the monumenting and recording of surveys. It is my opinion that every survey creating new land lines should be recorded in the public records, and that such lines should by statute be required to be suitably monumented and such monuments shown in the survey record; further, some one should be responsible for the preservation of existing monuments. It often occurs that monuments carefully set in a survey are ploughed out by road supervisors, or the contractors of county commissioners, sometimes through carelessness, but more often because of their having no knowledge of what they are, or where they are.

I hope that the matter of legislation will be well and carefully considered before anything further is asked for in this line. If we cannot get all that we would wish for, let us take what we can get as a starter.

I again wish to express my disappointment in not being able to be with you, and hope you will all feel, when the meeting is over, that it has been a pleasant and profitable one.

REPORT OF COMMITTEE ON GENERAL ENGINEERING.

J. L. GILPATRICK, GRANVILLE.

If your committee should presume to give even a brief summary of the notable engineering enterprises which have been undertaken, or completed during the year 1896, we might be chargeable with the profitless business of "carrying coals to New Castle." Perhaps, the most notable engineering projects which have been carried on during the year, in this country, are the Chicago drainage canal, the utilizing in larger measure the Niagara Falls water power, and the new water supply reservoir for the city of Boston. The disturbed condition of business has restrained men from embarking in any enterprises which were not either matters of necessity or of assured financial success. While the year has been one of general and almost universal depression, it has not been without good results. From sheer necessity the people have been compelled to call a halt upon the

reckless undertakings of many public benefactors so called. It is confidently believed that the year just closed will mark the beginning of a long period of wide-spread but gradual prosperity. Men have been forced to get their bearings, or in terms more expressive than elegant, to determine where they are "at." And this, not only in relation to money and investments, but as well in relation to all public duties and public improvements which should contribute to the well-being of society in general and to the good of the individual in particular.

Up to the present time our people have been restricted in the forms and character of their improvements by lack of means in part and in part by the selfish and unjust desire to get much for little or something for nothing. As a consequence of such causes our public highways are abominable for travel and an offense to good taste; our railways are only tolerable; our bridges in many cases have been death-traps; our dwelling houses in town and country are lacking in durability, convenience and beauty; our farming has been crude; our villages and smaller cities and many of our larger cities are either absolutely destitute of any adequate system of drainage, or are only moderately supplied. And yet in this country can be found a higher grade of knowledge and ability in every line of industry than obtains in any other country in the world. We make more machinery and better and more varied in its application than any other country; our natural resources are second to those of no other country.

It is hoped that we have arrived at a stage of development in this country whence better things shall obtain.

The wheelmen are clamorous for better roads. But if the roads meet with any substantial improvement it will come as a result of some comprehensive and intelligent plan as to grade, construction and repairs. The money now expended must be expended under wiser and more careful supervision. Additional revenue for road purposes could be secured if our laws were amended so as to arrest every tramp who is now terrorizing country and town and compel him to pay in labor upon the public works for every meal of victuals and every night's lodging given him. As to the plan for road improvement, the engineers of this

state can submit a judicious one, the public knows that we can, and will hold us responsible if we neglect our duty.

For some time our large cities have been struggling with the problem of sewage disposal. Under the laws of our commonwealth the State Board of Health is refusing, and none too soon, to permit the village and smaller city to continue to pollute with their waste the smaller water courses.

Diphtheria and the whole train of what are known as "filth diseases," which have been so widespread during the last six months find rich fields for conquest in those regions where good drainage is unknown or neglected. It is the high privilege of the engineer to co-operate with the physician in an effort to solve the drainage problem for our villages and smaller cities. There is no branch of engineering which ought to be in so great demand today. There is no branch fraught with such beneficent results to the people at large; no branch which would give employment to so large a number of idle engineers as that of sanitary engineering.

Every engineer in the proper sense of the term is a promoter of the enterprise in which he engages. If he proposes the construction of a system of water works he labors to educate the people to appreciate the value and convenience of a good water supply. As a sanitary engineer, he cannot serve his generation to better purpose than by helping to educate the people to appreciate the advantages of good drainage, and to the building of such a system as will meet the wants of a given community. There are in this state and in every state many villages and small cities in sore need of a drainage system, but they are poorly able to build even a "separate" sewer system and still less able to build an old time "combined" system. It may be that the state will have to come to the rescue of such communities and aid in the construction of such works, just as Massachusetts has done for the city of Boston in the matter of its new water supply. If such a step should be taken by the state, some additional legislation will be necessary, and it may not be too early for this Society to consider what enactments should be made.

The irrigation of the arid lands of the West is a question of

interest. Though much has been accomplished in the line of demonstrating the effectiveness of irrigation, still, problems involving large investments and effecting areas estimated by millions of acres await a practical solution by engineer and capitalist. On a smaller scale, but not less important is the matter of irrigation to the market gardener and to the grower of small fruits within our own borders. The ill effects of a rainy season, in very large degree can be counteracted by thorough tiling, but the blight of a dry season can only be met by irrigation. What can we suggest, what can we do to alleviate this unnatural suffering of nature?

At the risk of trespassing on the dominion of another committee, we will conclude this report by raising a few queries concerning the county surveyor: Are there any sufficient and easily available official records being kept of the surveys made by county surveyors? Are these records in any respect uniform over the state? If not, then what steps ought to be taken to secure uniformity, in the descriptive records, in the plats of surveys, in the indexing of both records and plats, and in the monuments for marking corners? Also, what can be done to secure remuneration for making the official record and plat?

It is well known that the old land marks, such as witness trees, line trees, and in many cases the corner stones, are obliterated; the public highways are encroached upon by the abutting land owners; the line of the highway itself is changed without authority, or even notice. The absence of suitable marks for lines and corners is the prolific source of neighborhood quarrels and needless litigation. That improvement on these lines is needed goes without saying. But if there is to be any improvement, it must emanate from the county surveyors themselves.

DISCUSSION.

Chairman Strawn: There is time allotted for discussing each paper as it is presented, and this is now open for your further consideration.

Mr. McKay: I think there is much in that paper worthy of discussion. The latter part of the paper in regard to county

records, I think, ought to be discussed by this Society, if there are any county surveyors in the room. I occupy that position in Greene county, and will say that I have been attempting to keep a complete record of all the work done by myself or assistants, and have made an effort to have all other surveyors furnish a record of their work to us, but I have only partially succeeded. My plan of making a record is to make a plat that would show a complete outline or sketch of the work, with some times a few lines outside necessary to make the proper connections; and index by townships, by sections, township and range, or military survey, whichever it may be, so as to definitely indicate the land.

One other point of the paper of which I wish to speak is the improvement of our highways. That, I think, could be discussed by this Society to advantage. In our county we have been making some improvements, but during the last two or three years, it has been mainly in the improvement of the grades of our highways, main lines of road. In many cases we found it cheaper to go around a steep hill than to cut it down to a reasonable grade. We have been trying to get a grade of five feet to the hundred as a maximum, but some times have to exceed that a little. I find that it is work that takes well with the people. If once introduced into a township and one or two improvements made, there is a clamor for more. In these hard times the work is being done very cheap, and is one of the means of furnishing labor to the unemployed.

J. C. Cromley, Lima: There is one question in that report that I can see the solution of. The laws of Ohio require what we call real estate appraisers every ten years to place a value on all real estate in the state, and these appraisers make a map of all the subdivisions, all lots, etc., in the state. These maps go into the county auditor's office and become a part of his records. These appraisers' maps and descriptions are full of mistakes, and until this duty devolves upon engineers, there will be the same difficulty. My idea is that the laws of the State of Ohio ought to specify what kinds of work should be done by a competent civil engineer, and should determine how we are to know a competent civil engineer. They ought to pass an examination, the same as

a physician, a school teacher or a lawyer. There ought to be some standard by which we could judge of the quality, and then when an engineer passes the examination, he ought to be permitted to do a great many things that are now done by some one else. That is one way of obviating those mistakes, and it is the only way to secure uniformity of descriptions. In the county of Allen, where it is congressional lands, and every section is supposed to be square and the surveying very simple, even there mistakes are made because the descriptions are furnished by the land appraisers.

G. S. Innis: On the subject of marking lines, I think we ought to be more particular in doing this, and I think it would be an advantage to the people for whom we work to have substantial corners put in. First be sure you are right, but when you are right, mark the place so it can be found and no mistake about it when it is found. Put in a good permanent stone and mark it in some way, and describe it in your notes. Then the legislature ought to prevent any one from writing deeds unless he knows what he is doing. Take a man and elect him justice of the peace, and he knows nothing about the descriptions of land, and the next day he thinks he knows how to write a deed. You will find deeds where the lines have been swapped. In such a case you have just to find the old lines, and if you find from them that they have been swapped, just swap them back again. It is better to take the pains to do that to keep the people out of lawsuits. I think surveyors ought always to try to make peace between landowners, rather than to stir up strife.

THE WORK OF THE COUNTY ENGINEER.

J. C. CRONLEY, LIMA.

The county engineer, like a county physician, is a person who from necessity has a general knowledge of a good many subjects, and yet, can claim no special attainments in any of the many subjects with which the civil engineer has to deal. He has the general public to serve and please, and must therefore accommodate himself to a variety of circumstances and to any emergency that may arise. Thus, from the nature of his surroundings as well as his relations to society, he becomes a diplomat or politician. Hence in many counties of the state the county engineer is selected, not with reference to his qualifications or abilities to discharge the duties of his office, but because he belongs to the dominant political party. We believe the interests of the general public would be better served, the duties of this position more easily discharged, the remuneration of the office better, if the offices of county engineer and city civil engineer were taken out of politics, and appointments made to these offices along the line of civil service competitive examinations. As it is, the first duty of the county engineer is to pay his political obligations and allegiance to the party that elected him, and afterwards look after the business of the office. In several counties of the State of Ohio the duties of the county engineer are so limited that the only thing he has to do is to fill his office and look wise, while his remuneration is so small that it would not pay his board bill at second-class hotel; however, in other parts of the state, and especially the northwest, where a great amount of drainage construction is made every year, the county engineer receives a very fair salary. The county engineer often labors under very great disadvantages, owing to the fact that the county commissioners in many counties of the state do a large amount of work that ought to be done by a competent civil engineer. This is not only an injustice to the county engineer, but to the general public as well. The evil, however, can only be remedied by legislation which shall specify what kinds of work shall be done

by a competent civil engineer. Road construction, drainage construction, bridge building and land surveying are the kinds of work which the county engineer is usually expected to do. To us, however, the subject, "road construction," is of far greater importance than any other engineering topic herein mentioned or likely to be discussed by this Association of Surveyors and Civil Engineers. Nothing adds more to the comfort, convenience or prosperity of a state than a system of good roads. Not a single mile of road ought to be built in any county in the state, except after the plans, specifications and profile, and under the supervision of a competent civil engineer. Most of the evil effects which we experience as the result of bad common roads, are the necessary consequences of our bad system of road management, which are derived from our antiquated legislation on that subject. The first step necessary in the construction of a road is to provide for complete drainage of both surface and subsoil. To do this it is necessary to construct both side ditches and sub-drains. The cross section of the surfacing material (preferably crushed stone) should show a crown of about three per cent. of the width of the pike. The width of the gravel or macadam should be not less than fifteen feet with a center depth of fifteen inches. Roll the same with a six ton roller and the work is complete. In our own county of Allen, we began piking in 1870 and have at the present time 510 miles of pike, of which 66 per cent. is macadam and the remainder gravel. Our roadways are forty feet wide, with a sub-grade twenty-four feet wide, on which the gravel or crushed stone is placed ten feet wide and ten inches deep. There is not a mile of pike in the county made after the plans and specifications of the county engineer or any other civil engineer. When the commissioners decide to pike a piece of road, they send the county surveyor out, who runs the center line of the road and drives four sets of stakes, measures up the work when the contract is finished, and his services on that road are ended. The average cost of our macadam roads is $2,000 per mile, while the gravel roads cost about $800 per mile.

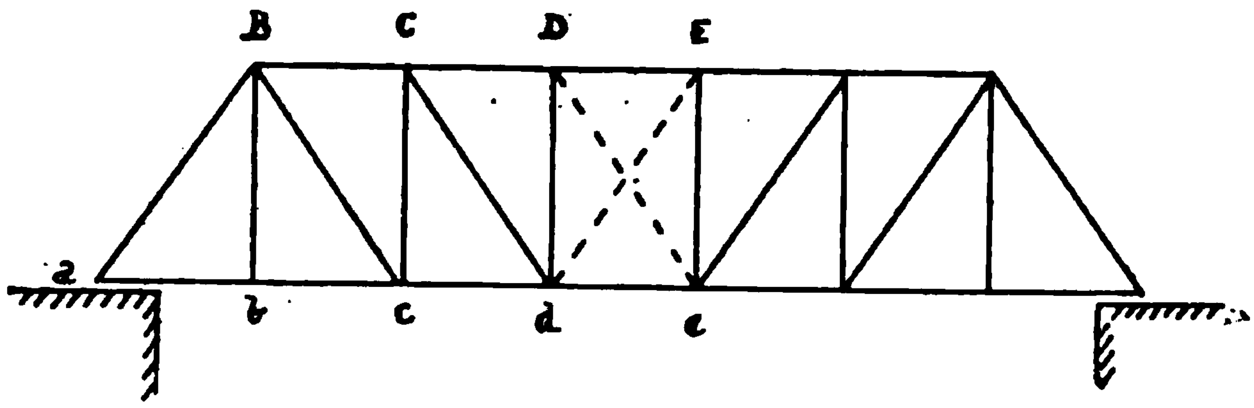
DITCHING.

Ditching is the most remunerative as well as the most perplexing work a county engineer has to do. In making up his apportionment sheet for the day of "ditch hearing," his judgment and skill is often taxed to the very utmost, while his patience on the day of hearing becomes completely exhausted. Only those, however, who have had experience in this line of work can fully appreciate the engineer's perplexity and distress during a ditch hearing. In connection with the subject of ditching we wish to call attention to one piece of work that was done by the city of Lima last year, which may interest some of the members of this Association. Lima is situated on what is known as the Ottawa river, a stream quite tortuous in its course, with a rock bed, full of pools, sand bars and other obstructions. On the east of Lima are the Lima paper mills, discharging their refuse into the Ottawa river. On the west the Solar refinery emptying its refuse into the Ottawa river. In the center is the city, discharging its sewerage into the river. The consequences were when the river was low, these discharges settled in the pools, producing a stench almost unbearable. During the dry season of '95, the smell became so terrific that the people who lived adjacent to the river made urgent demand upon the council for relief. A great many means and measures were discussed for the removal of the nuisance. Some advised one thing, some another. Some said build a large sewer and carry the sewage out of the city. Others said build a precipitating plant; and still others said the paper mills ought to be removed. All agreed that the city ought to do something, yet no two agreed as to what remedy should be proposed. At last the council petitioned the county commissioners to ditch the river and the problem was solved. A channel eight feet wide and averaging three and a half feet deep was blasted in the center of the river bed; all pools were filled and sand bars removed. This simple and inexpensive improvement has furnished complete relief from the vile odors and stenches which have so long been a menace to the health of the city as well as an unbearable nuisance. Now the banks of the Ottawa river have as pure

atmosphere as any other part of the city, and no longer is the vicinity dotted with placards of scarlet fever and diphtheria.

BRIDGE BUILDING.

Bridge building, the next subject to which I ask the attention of this Association, is a branch of civil engineering not generally understood by county engineers; neither is it necessary that he possess a technical knowledge of this branch of engineering, if he is able to make a genral plan and set of specifications, compute the strain on the different members of the bridge, it is all the duties of the office require of him, or that is necessary as to the superstructure. As to the masonry, however, he should be able to make a complete set of specifications and drawings, showing the length of abutments, face, angles, height of wall, batter, base, bridge seat, width of bridge, length of bridge, kind of stone, size, joints, mortar, pointings, coping, excavation, back filling, kind of masonry, etc. The following figures, taken from actual experience, will perhaps better illustrate my ideas of this subject than the paper itself:



High truss, 7 panels, through span, single cancellation.

CHORD STRAINS:

BC and cd=(abt. Reaction×21−one panel load×1)÷h.

CD, DE and de=(abt. Reaction×31—one panel load×21—one panel load×1)÷h.

ab and bc=abt. Reaction×1÷h.

Ba=(6+5+4+3+2+1) $\frac{1}{7}$ L. L. on panel×Diag.÷h+D. L. on 3 panels×Diag.÷h.

Bb=one panel load.

Bc=(5+4+3+2+1) $\frac{1}{7}$ L. L. on panel×Diag.÷h+D. L. on 2 panels×Diag.÷h.

Cc=(4+3+2+1) $\frac{1}{7}$ L. L. on panel+D. L. on one panel.

Cd=4(+3+2+1) $\frac{1}{7}$ L. L. on panel×Diag.÷h+D. L. on panel×Diag.÷h.

Dd=(3+2+1) $\frac{1}{7}$ L. L. on panel.

LAND SURVEYING.

Land surveying is so extended in its application that it applies in its various forms to an almost infinite variety of problems and legal questions. We will not ask the attention of this Association, however, beyond the consideration of two problems. The surveys of the public land of the United States have been made from reference lines called the principal meridian and its base line. From these lines, guide meridians and standard parallels are run, north and south from the base line and east and west from the principal meridian, twenty-four miles in each direction. From each township corner on any standard parallel auxiliary meridians are run north to the next standard parallel. Since these meridians converge somewhat toward the principal meridian, they will not be six miles apart when they reach the next standard parallel. The convergence of the meridians is in angular amount, C= m sine $\frac{1}{2}$ (L—L′); where m= difference of longitude and L and L′ are latitudes of the two positions. The convergence of two township lines six miles apart, from one correction line to another twenty-four miles apart, in latitude 40°, is C= 24x80xsine C. C= 6-53 sine 40°. Natural sine 40° = .64279. .64279x $\frac{6}{53}$ = .0726° — 4.36. .00029x 4.36 = .0012644. .0012644x1920 = 2.42 chains. Therefore C=2.42 chs, which is what the northern tier of sections in the north range between correction lines lacks of being six miles east and west. To run out a true east and west line or parallel of latitude, it is necessary to make use of two tables: One to give the proper offsets from the great circle to the parallel of latitude tangent to it at the initial meridian, and the other to give the change in azimuth necessary to prolong the line from a new meridian when no new observation for azimuth can be obtained. The offsets are to be always measured to the north of the tangent straight line, in the northern hemisphere and south from it in the southern hemisphere. Thus in latitude 40°, having started from a given point due east, and run out a straight line for six miles, we find by the table that the true meridian is found by turning off from east to south, 89° 55′ 38″, and the true position of the parallel

at this point is 20.1 feet north of the line. When twelve miles have been run in one continuous tangent line the angle with the meridian is 89°—55′—17″, and the offset 80.5 feet to the north of the line.

In addition to a general knowledge of the above subjects, the county engineer ought to be able to make use of the applications of the Kutter formula for the velocity and discharge of water by gravity as well as the hydrostatic formula for the velocity and discharge of water through pipe under pressure.

Beside these acquirements, and more important than all, he should exercise an intelligent judgment and good, common, hard sense to the every-day duties of the office.

DISCUSSION.

Mr. McKay: I would like to ask Mr. Cronley a question or two: Do you use any binder with your stone roads, any binding material, or do you use screenings, or just put stone on and let it wear down?

Mr. Cronley: I will say to that that nearly all our macadam roads are made with the stone crushed to a certain size named in the contract, and that with the screenings and everything is put on the road together. There is no top dressing. In a few places the township trustees put gravel on top; but the gravel is of poor quality and cuts through and ruts up. There is no road, in my opinion, as good as a crushed stone road. The great drawback with us is that we do not use rollers. We put the stone on ten feet wide and the wagons must run over it two or three years before it is worn smooth.

Mr. McKay: What kind of stone do you use?

Mr. Cronley: Limestone.

Colonel Innis: Explain what you mean about drainage?

Mr. Cronley: My idea is to place tile on each side of the gravel under the sub-grade. More or less water gets through the gravel or stone and there ought to be something there to carry the water off. I am in favor of side ditches on each side to carry away the water which runs off the road bed, and two rows of tile to carry off the water which seeps through the road material.

Mr. Gilpatrick: Do these tile run longitudinally with the side ditch?

Mr. Cronley: Yes.

Mr. Gilpatrick: How large are they?

Mr. Cronley: I think four inch is large enough.

Mr. Gilpatrick: Placed on the side?

Mr. Cronley: About three feet from the edge—along near the edge, is my idea. Not right at the edge, for it might be disturbed.

Mr. Gilpatrick: How much below the crushed stone?

Mr. Cronley: Three or four inches below the surface of the sub-grade would be sufficient.

Chairman Strawn: In our city we have built a number of slag roads, of slag road metal. On all these streets we have put underdrains of four-inch drain tile, out within about two feet of the edge of the road. We have the road bed generally about twenty feet wide, and I have found that without drainage, there are very few soils that will enable us to maintain a good roadbed. The roadbed must be drained in order to secure permanence and then the maintenance after that is reduced by keeping the roadbed well drained.

Mr. Gilpatrick: Cannot the necessity for underdrainage be obviated by keeping the surface in good repair, having a crowning surface, perhaps an inch and a half in width of twenty feet, and could it not be kept in good repair at less expense than putting in underground drainage? It is a fact that repairs on our roads are not made in time. The old adage, "A stitch in time saves nine," applies to roads as well as other things.

Mr. McKay: In our county we have introduced a style of roadbed during the last three or four years which is different from what was used previous to that time, and I think it is considerable of an improvement over the old style. We make a flat top and then make the road crowning from that to the center, about a half inch to the foot for the width of the road. Then we put on the material, either gravel or broken stone, then just enough material to hold it to place. Before the side boards are taken up, we take one of the improved graders and further cut

off that edge and edge up to the broken stone or gravel, and it holds the material to place. When we first introduced this method, the farmers were inclined to think it would hold water, but that has been proved to be a mistake. We have sufficient side ditch and a good crowning road, and if it is kept in repair there is never water standing. To the first road we had considerable opposition, but in one year after the people who lived on the road said it was the proper thing. Another thing, if a man happens to go into the ditch he is not apt to upset, as the side slope is so gradual. One word further in regard to stone roads: We have built stone roads in our county, and some have given good satisfaction, and some have not. The first did not give as good satisfaction as they might, and the reason was because the stone was crushed too coarse. Our specifications required the stone to be crushed, the largest dimension not to exceed two inches and a half; but between the contractors, the commissioners and the public, they rather beat me out on the first contract, and I could not enforce the specifications. But after that there was no trouble to enforce the specifications and there has been no complaint. We have been making them two ways. In one it is screened and the coarser stone put in the bottom with the finer on top, and we find that gives better satisfaction than to mix it; but either will do if you keep the fine from depositing in one place.

THE FLOOR SYSTEM OF HIGHWAY BRIDGES.

C. S. DAVIS, TOLEDO.

Mr. President and Fellow Members:

One of the first questions that comes to my mind as being of special interest to this society is, "Are the highway bridges as built today up to the standard we require for our present traffic?" In most respects, I am happy to say, they are, but in some respects there is room for improvement. The most notable weakness, if I may be allowed to speak of it as a weakness, occurs in the floor system, and it is to this that I wish to call your attention for a few minutes.

A great many notices of bridge lettings specify that the bridge shall be proportioned to sustain safely a load of 100 pounds per square foot with a factor of safety of four or five, as the case may be. All bridge companies bidding on the work will naturally design as light a structure as possible and at the same time have one that will meet with the requirements of the notice. This follows from the fact that the lowest bidder stands the best chance for securing the work.

The load of 100 pounds per square foot is amply large for proportioning the members of the truss. It is even more than is necessary in a majority of cases where it is not sufficient in the floor system. The floor system and especially the floor joists, should be proportioned for a concentrated or wheel load. There are but very few bridges in this state but that will at some time have to carry a heavy concentrated load. One of the most common of these is the traction engine. The maximum wheel loads of traction engines as built by Russell & Co., of Massillon, O., are about as follows:

Max. wheel load with 6-horse power engine, 2,600 pounds.
Max. wheel load with 10-horse power engine, 3,870 pounds.
Max. wheel load with 13-horse power engine, 4,180 pounds.
Max. wheel load with 16-horse power engine, 4,640 pounds.

To make the matter clear, I will assume a case where the panels are 12 feet long and the joists spaced 30 inches apart,

center to center. This is a common spacing for joists in country bridges. The maximum load on one joist from the 100 pound load will be 3,000 pounds. This is equivalent to a center load of 1,500 pounds, or less than one-third the maximum wheel load of a 16-horse power engine. In other words, to design a floor system that would safely carry a 16-horse power engine, we should use a uniform load of 300 pounds per square foot instead of 100. As the panel length increases, the difference between the concentrated load and the uniform load of 100 pounds per square foot decreases. For example, with a panel length of 20 feet, the total load on one joist due to the uniform load will be 5,000 pounds; but this is equivalent to a center load of 2,500 pounds or a little more than one-half the maximum wheel load of a 16-horse power engine. Now, it will be seen, that if we continue to use the uniform load in proportioning the floor system of our country bridges, we should use a very much larger load than we are using to-day. We might do this and use one loading for the floor system and another for the trusses, or we might do what is better, and proportion the floor system for the heaviest load that is liable to come upon it and proportion the trusses for a uniform load.

The large number of suburban and inter-suburban street railways that are being built now makes it important that we should give more attention to the design of the floor system of our bridges. Some of these roads are taken across old bridges without having the joists properly strengthened.

In the last edition (1896) of his Highway Bridge Specifications, Theo. Cooper divides highway bridges into five classes, which are as follows:

Class A 1—City bridges having buckleplate floors and an accepted form of paving resting on a concrete base.

Class A 2—City bridges having plank flooring.

Class B 1—Suburban bridges or bridges carrying heavy electric cars.

Class B 2—Town or country bridges carrying light electric cars, or bridges carrying heavy loads from quarries or manufactories.

Class C—Country bridges carrying only ordinary highway traffic.

He specifies the following floor loads for these: A 1 and A 2 100 pounds per square foot, or 20 tons on two axles, 12-feet centers. B 1 100 pounds per square foot or 12 tons on two axles, 7½-feet centers, or 5 tons on 2 axles 8-feet centers. B 2 100 pounds per square foot, or 8 tons on two axles, 8-feet centers. C 80 pounds per square foot.

This method of proportioning the floor system will give larger joists than are usually used, but at the same time the results are enough better to make it worth while. The loads specified by Mr. Cooper may be a little too heavy for bridges in remote country places, but yet his method of using concentrated loads is good. I believe if this method were more generally used our bridge construction would be improved.

DISCUSSION.

Mr. Wolverton: I will refer to an instance which came under my observation among the counties in the northern part of the state. There was a bridge there of 160 feet span, over which it was desired to run electric cars. They simply put in another floor and just put hoops of strap iron on the top floor and run the electric cars over it. It deflected just an inch and a half in the center for every street car that went over it. I was called as an expert to see if the bridge was safe to carry the cars or not. I went up there and saw the commissioners. I suppose they have a county surveyor, but I did not see him, and from all appearances they had not consulted him. I reported that the bridge was not safe, and I believe the commissioners issued an order prohibiting the street cars from running over the bridge until it was properly repaired.

Mr. Gilpatrick: I cannot forbear a remark upon the esteem in which the county surveyor is held by the commissioners. I am quite in sympathy with the suggestion made, for while county surveyor of the adjoining county of Licking, and although holding down a chair in that office for a year, I have never yet been called to consider any question touching bridges. It is a disgrace

that the county surveyor either is so poorly equipped or so poorly consulted about these matters. It is a noticeable thing, too, that when a competent engineer comes along and finds you a county surveyor, he passes you by in silence, in practical contempt.

Mr. McKay: My opinion is that whenever the county surveyor shows the county commissioners that he is competent to handle these questions, they are glad to avail themselves of his knowledge. It is true that the county surveyor is held in more or less contempt by most bridge men and other engineers, but if a competent man happens to become county surveyor they will soon learn to respect him if he does his duty. That is my opinion.

Mr. Gilpatrick: Yes, if he happens to be on the same side of the fence as the county commissioners.

Mr. McKay: In our county it is all one-sided, any way. But it ought not to be a political office at all.

Mr. Cronley: I think the paper worth discussion, and I heartily agree with the thoughts contained in it. I know in my own county and in others with which I am acquainted, the subject of flooring is never considered. The commissioners authorize the engineer—some do and some do not—to design in a rough way a bridge. In our county we draw the plans and specifications for the masonry, compute the strain on the bridge as described, and the commissioners usually use a factor of safety of four, but nothing special about flooring. But the floors in our county never give way, though they sometimes wear out. The trouble has been that we built our bridges too light, and are now going to the other extreme and design them 150 pounds to the square foot. I do not know whether there are any in Columbus that heavy, but we are on the safe side. A traction engine weighing 8,000 pounds broke the last bridge down. The owners sued the commissioners and got judgment.

Mr. Davis: A load of 150 pounds per square foot is entirely unnecessary for the truss members. The extra material put into the trusses to carry the extra fifty pounds might better be put in the floor and give a much better bridge for the same money.

Mr. McKay: In our county on small bridges of 25 up to

40 or 50 feet span, we use 150 pounds in designing truss and floor system, too. In longer spans, we use 80 to 100 pounds in truss system and put in a hundred pound floor system. In one bridge of 166 foot, which is rather a long span for our county, the county commissioners insisted on a hundred pound bridge, trusses, and we finally used eighty pound truss and a heavy floor but I insisted that a hundred pounds was unnecessary for the system; and the extra money put into the floor system I think well spent.

Mr. Cronley: I don't think it proper to design one part of a bridge for one load and another part for another load.

Mr. Davis: Take a bridge of 150 foot span. One panel of that bridge may receive its computed load every day, but not once a year will the bridge receive the full panel load on every panel in the bridge. Probably, no bridge of 150 foot span ever receives a load of 100 pounds to the square foot over the whole surface. The only point is that the floor system is more liable to receive its whole or computed load than the whole bridge is.

Mr. McKay: I think the better way is to design for the contemplated load on the floor joists.

Mr. Davis: I think so.

STRICT INTEGRITY A NECESSARY QUALIFICATION OF THE ENGINEER.

J. B. STRAWN, SALEM, OHIO.

Since this paper is intended as a supplement to the "Report of the Committee on General Engineering," it will, like many other supplements, be found to contain nothing of importance, upon engineering, either "general" or special.

In glancing backward over the period covered by the life of the Ohio Society of Surveyors and Civil Engineers, the writer has been constrained to depart from his usual custom; which, in the main, has been one persistent cry for water—more water—better water—and more light, and better light. In fact he began, most seriously, to question whether a "rest" from a further pursuit of a subject, the very name of which suggests that you must dam it, to keep it from running down hill, had better be turned to something else for fear of the affliction of "water on the brain," or "light" headedness. And since men love "darkness rather than light," we will turn out the light also; that men may enjoy their loves.

Since the organization of this Society mighty achievements have been chronicled, more stupendous than the world ever before had witnessed in any country. Since these things could never have transpired but for the engineer, the writer, after deliberating for some time on what to say, or rather what not to say, finally settled in his mind that a paper could be presented which would bring before this body some of these mighty works; not so much of the older works, but of some of those which mark the present short period, substantially covered by the past quarter century. The writer's long acquaintance with the engineers of this Society has led him to appreciate the sterling integrity found among its members, ever ready for a kind word of just praise when justly merited. Yet no class of men are more candid and just in their criticisms of what they believe is unsound, untrue or impracticable than are the engineers of this period. The man who deserves the title of engineer—and, you will understand the title is to be considered

in its broadest and most comprehensive sense—is a man who detests every thing that savors of, or is branded with the word shoddy; whether it be in material, workmanship, design, or in the elements of human character. He demands that everything must stand the "test" he requires. Everything must be in accordance with the "specifications" and the "contract." Material of light weight, or of inferior quality—whether that material is to enter into some public or private improvement—or into the make-up of human character, must be rejected; and sound material of full weight and sound character of full weight, be substituted for the inferior and unsound. All admire truth, nobility, and sound characters.

We have often heard of the fellow "born with a silver spoon in his mouth," and, further, that in nine cases out of ten he has proven a failure. Some have supposed that the failure was due to the spoon being too small. More likely his mouth was too large, or that he needed more ballast. And he might possibly have failed if the spoon had been of gold. Too often when the crucial test comes, the young man of rich ancestors realizes that there has been a pretty large amount of shoddy mixed into the warp and woof of his character. It won't stand. It won't wear. It lacks the strong fiber of life and strength to withstand the stern realities of this surging, heaving life and scramble with the "foot ball team" in business life.

We often indulge in self adulation and natural admiration. We may say, "If no one else thinks well of us, is that any reason why we should not think well of ourselves?" But "we should not think more highly of ourselves than we ought to think, but to think soberly," truthfully, honestly.

What the world to-day stands most in need of is men—men of sound moral principles. Men of upright characters. Honest men. Not mere men, so much, as better men. Nowhere is the demand for men of strict integrity more urgent than among the men who are ranked as engineers. And nowhere do we find this requirement so completely met as among our engineers. It is probably true that no other class, or profession, engaged in secular pursuits, enjoys a cleaner record, or enjoys a higher

standard for integrity than do our engineers. This statement is not made in the spirit of self-adulation or vain boasting. It is the writer's candid summation of the men who, through patient toil and strict integrity, professional skill and ability have been elevated to the position of counselor, judge and arbitrator in the broad and far-reaching improvements of the country.

The education and training of the young man for the calling of an engineer seem pre-eminently fitting to develop the special trait of character of which we have spoken. In his mathematical studies he deals with the positive, and kindred branches which will be pursued in his course of study, train him to reason from known facts—from cause to effect. He sees in miniature, numerous plans and models. He witnesses the testing of materials for determining their properties and qualities, their adaptability for certain purposes. He acquaints himself with the materials he is expected to meet with in constructive work. He early realizes the importance of being exact in all his work. His work must prove. He learns the relation of cause and effect. He thus becomes grounded in very truth. His training in field practice with the corps is in the same direction. If he is acting as rod man on a railroad or other survey, his notes must tell the exact reading of the level. In measuring, he soon realizes with what precision every station must be marked. In the office, his calculations, tracings and copies must be precise and complete. All of this training tends to bring his whole being into harmony with exact truth. His head is being adjusted, squared, plumbed and leveled. A level head is a valuable possession for every one to have.

As he assumes the responsibilities of the engineer his ambition is to do his best, and make no mistakes. His life work lies before him. As yet, his reputation is a negative quantity; his character he knows is a positive quantity. He now stands at the bottom of the ladder; he cannot see its top. He sees that it rests on the rock, and his ambition is to reach the greatest possible height. Each succeeding round he mounts prepares him for something better, higher, broader, beyond. Each step upward he makes sure, for he has the power which enabled him to take the first step, to which is added whatever experience and knowl-

edge was thereby gained. But yet, his "hind sight" is short; but it coincides with his original fore sight. One of the important things about these annual gatherings may be summed up as "foresights" into new fields, new methods, new formulas, new improvements; for they who would serve must know how.

Upon the generally accepted hypothesis that true merit will be recognized and rewarded, let us briefly pass in review on some of the evidences which go to prove why the engineer has been, and is, and will continue to be, the most potent factor in planning, executing and pushing to the front the mighty undertakings which mark the world's progress, and tell so much for humanity and civilization.

Not only has the engineer gone everywhere, but he has seen everything under the sun—upon the earth, and upon the seas, and under the earth, and under the seas. He walks upon the bottom of the sea. He mounts upward to the clouds and talks with the thunder. He communes with the lightning, and with the lightning he talks with his friends across the seas. He has measured the winds and studied their courses, and weighed them upon the mountains and in the valleys, and taken knowledge thereof. He knows the rivers of the oceans and has given them names. The mariners counsel him; he tells them their courses and they follow them.

He has penetrated the earth, and forthwith there flowed rivers of oil. He taps the great retorts of gas, and therefrom he lights the world. He tunnels the mountains and bridges, the rivers and chasms, that he may lay bands of steel from ocean to ocean, whereon the rushing, fiery steed may glide with his train as swift as the wind at his best. He joins sea to sea by severing the narrow necks of land which bind continent to continent; and through these channels float the majestic ships of commerce. The Mediterranean and the Red Sea, since creation's dawn up to 1869 were separated. Since 1869 the two seas have been united in the bonds of friendship, and Africa now is an island. It is "surrounded by water."

The engineer has been the faithful guide. Yes, the pioneer in almost every field of exploration. There is no country on the

face of the earth that he has not explored—no islands of the oceans and seas that he has not visited. While as yet, no one claims to have reached the north pole, yet, Dr. Nansen, on the 7th of April, 1895, was as near the north pole as some of you were to Columbus yesterday. "Nansen there stood among the ice hummocks of the Arctic ocean at a point 195 miles nearer the north pole than any man had ever been before." "For the last 150 miles of his journey north Nansen had not found the slightest trace of life in the air, on the ice, or in the ocean depths. About the 84th parallel, he seems to have passed from the life zone into an area around the pole where nature is wholly inorganic and inert." See McClure's Magazine for December, 1896.

Nansen has proven himself not only a wise navigator, but he has proven himself an engineer of rare ability. His calculations were all substantially verified. No accident, no sickness from the day of starting until his return. Nansen demonstrated to the world how to build a ship for Arctic ocean navigation. Experts so called predicted the Fram would be crushed in the ice packs she would meet. Not so. When the ice closed in around the ship, instead of the ice crushing her, it simply lifted her on the ice. Hence the bottom of the ship near the keel was made almost flat so she would not capsize while on the ice surface. He also carried his electric light plant. The wind furnished power part of the time, and his men supplied power, when needed, if the wind failed him. He also had a phonograph which was a means of cheering the little cabin. He had many songs of his wife, who was a noted vocalist of Christiana, to cheer him and his party. We must not stop longer here; there are others we must see, and spend a few moments with. Our time will not permit of going far back to note the great engineering achievements of ancient times. In fact we scarcely think of those now. The pyramids and sphinx of Egypt are small affairs when contrasted with some of our modern structural works.

Let it suffice, for our purpose, to look at a few of the achievements of the quarter century just passed, most of which may be considered from an engineering point of view. One of our most trustworthy statisticians says: "In 1870, by the census returns,

the United States possessed property valued at $30,000,000,000; or, reduced to a gold basis, $24,000,000,000. In 1890 the same authority shows us worth $65,000,000,000 in gold, a gain in twenty years of $41,000,000,000, almost twice as much as it was able to accumulate from the time of the discovery of America up to 1870. Nay, more, these $41,000,000,000 represented a sum greater than all the savings of the entire race from the days of Adam to the first, and possibly the middle of the eighteenth century."

It may be interesting to turn from the pursuit of our phenomenal financial prosperity and contemplate some of the recent outlays in public and private undertakings, as well as to mention some of the great engineering projects now under way, and others projected.

New York will be the center of the most important engineering works in the near future. But a very few years have elapsed since the opening of the great Brooklyn bridge; which, at the time, was by many thought to be far in advance of the city's requirements, but the cities have outgrown the bridge, and now there is under construction another, the new East river bridge, with a capacity about double that of the famous Brooklyn bridge. This is designed for local traffic only between New York and Long Island.

Another bridge across East river to cost over $10,000,000 is the great railroad bridge, which will be built by private capital.

And yet another, and as one of our engineers says, "Will be the largest single structure ever built in the history of mankind." This will be the gigantic bridge over North river, contemplating a single span of 3,100 feet, almost three-fifths of a mile, and which, with all the accessories of land and approaches, will cost $40,000,-000. It will carry eight railroad tracks, besides roads for bicycles and promenades, and will afford entrance into New York for thirteen railroads."

Another valuable improvement will be the completion of the long-delayed tunnel under the Hudson river. "This work was commenced more than twenty years ago, and is now about

half finished. The tunnel will be used for local traffic on two tracks, with electric cars from shore to shore."

Another important tunnel project is the Brooklyn and New York rapid transit tunnel, with electric power, from the lower part of Jersey City to Cortland street in New York, and thence under the city and under the East river to Atlantic avenue, Brooklyn. This will cost $25,000,000. This line proposes handling the steam railway traffic between Brooklyn and New York.

It is estimated that the capital that will be put into circulation by the construction of the new engineering works for New York city will reach $140,000,000. In addition to the above, the State of New York has provided funds to the amount of $9,000,000 for deepening the Erie canal, which work is now in progress.

Another important matter is now being urged for passage by the New York legislature, viz: The elimination of railroad crossings.

Leaving New York, we find that in other parts of the country a vast amount of private as well as public engineering work will be put under way. Another great engineering work is the new Southern Railway terminal for Boston. This will accommodate twenty-eight tracks, which will hold 350 passenger cars. The platform area will accommodate 25,000 people at one time.

Another stupendous engineering undertaking is the great Chicago drainage canal, now about half finished, which will connect Lake Michigan, through the Illinois river, with the Mississippi and give communication with the ocean.

The design of this canal is two-fold, viz: "To serve for the drainage of the city, and make it the largest port for inland navigation." The entire cost, $30,000,000, is borne by the city of Chicago. Chicago is called the "Windy City." Henceforth it will find some use for water as well as "wind."

It would be a pleasure, had we the time, to enter into a fuller description of some of the monster engineering works now under construction and under contemplation, but this cannot be done now, for there is a limit to patience and forbearance.

There are a hundred topics which might claim our attention, which are of special interest to the engineer; either of which

could, with profit, be treated in detail—which would grow and expand into volumes. For the present we must pass, as it were, through this great library, without stopping further than to read a title here and there, and pass on and out, and close the door. Some of the titles, as we now remember, read as follows: "The Present and Future Industrial Activity in America," "Electrical Progress," "Introduction of Electricity in Mining and for Running Heavy Machinery," "Utilization of Water Falls for Generating Electric Energy." Successful transmission of power over long distances by dynamos of several thousand horse power are now introduced by Siemens & Halske at Johannesburg.

Note.—"Investigations of the last few years show that large net works of electrical conductors tend to weaken the violent action of thunderstorms, and to decrease the danger from lightning."

The increase in the building of electric railways gives great promise for the future. This industry seems but begun. The application of electricity for conveying intelligence and power is becoming so universal that, with improved methods in rapid transportation by land and by water the whole enlightened world has become so unified and bound together in commercial and industrial relations, interests and activities, that we no longer exist as separate and independent nations and countries. The electric wire has been, and will continue to be the great messenger of universal peace and good will to mankind. With improved machinery, improved labor saving devices for cheapening productions to meet the daily requirements of mankind, a deeper and fuller acquaintance with the world's mineral wealth, and the agricultural possibilities of our soils—for, from the earth must come all riches and wealth. With a fuller development of all these, will also come the necessary leisure from physical toil, to permit of intellectual culture and mental development, or education. For without leisure no people can become enlightened or educated.

Through the labors and influence of the engineers, great and mighty forces are now pushing out in every direction which are destined to leaven the whole world and make one brotherhood of

all mankind. We ask, could any of the grand conceptions and conclusions, and plans of the engineer ever have materialized or been consummated, except through the integrity known to repose in the engineer? The fact is that all new ventures in the material world have been staked upon the favorable showing of the engineer. He is the constant, faithful counsel of the investor of capital.

In both public and private works of magnitude the engineer directs in the expenditure of more capital than any other class, and possibly more than all other men combined. Hundreds of millions of dollars annually are expended under the wise counsel advice and direction of the engineers.

The outside world may rise and tell us that even some engineers have been wanting in integrity. Very true. The most renowned engineer of France in 1892, M. De Lesseps, whose fame was known in all lands more than any other engineer, was convicted of stupendous crimes in connection with his last great undertaking, and in his old age languished behind prison bars, a most pitiful object, indeed; but in no class of men was there keener sorrow felt over a man's misdeeds or downfall than was felt by the engineers of the world, for De Lesseps then belonged to the world.

The writer believes he voices the real heart feeling, not only of this Society, but of the profession at large, when he says that it is with sincere regret we have brought to our knowledge the downfall of any man who has done valuable service as an engineer. And again, no class of men are more ready to applaud, or rejoice over the achievements and successes and triumphs of our brother engineers than we are ourselves. The engineer who will belittle or prostitute his profession by accepting bribes and boodle should be adjudged as a leper, and when approaching a brother engineer should be compelled to raise his hands and cry, "unclean, unclean." One of our poets says:

"In other worlds devotion may have bliss,
I'm sure 'tis honor that must save in this."

Another,

"Mine honor is my life, both grow in one;
Take honor from me and my life is done."

The conclusion of Mr. Strawn's paper was followed by hearty applause.

DISCUSSION.

Colonel Innis: I want to commend all of that paper, but especially the latter part of it. I think that without strict integrity an engineer ought to quit the profession. One thing, however, is a comfort, where he has not strict integrity, he pretty soon does quit. I have known several whom I thought and the public thought were honorable—I will say a few, not several—who were not above taking a bribe or some sort of consideration to favor one side or the other where called upon to decide between individuals or between the public and an individual. But in every case they are not in business now. Would you call on a man to do work for you whom you knew would be guilty of taking a bribe? I think not; and an engineer might as well commit suicide, professionally, as to undertake to depart from the line of strict integrity. The worst kind of a helper to take along is a jug of whisky. I have known some to do that. However, when they made a ditch a mile and a half long and it rained the water ran the other way. Then, Mr. Chairman, suppose you and I have a difference of opinion and we call upon one of our brothers here to decide between us. Can you think of anything worse than he would be if he would be moved in his decision by even any good feeling he might have towards you or any ill feeling he might have towards me? It is pretty hard when one man is a gentleman and the other a disagreeable fellow, to do exact justice to the disagreeable man, but still if it is just to do it, you cannot afford to do otherwise; and I am proud to say that civil engineers generally do it.

Mr. Strawn: I took the pains yesterday to go to the office of the Board of State Charities and there examined the records of the penitentiary. I was anxious to see whether we had any brothers in the penitentiary. I found a great many other professions represented there, and by the last report I found there was one engineer there. I felt curious to know what he had done, but had not the time to ascertain. But I was surprised to find that the class of men who understand the law and ought to know how to keep out of his clutches was represented there ten to one.

REPORT OF COMMITTEE ON LEGISLATION.

J. D. VARNEY, CHAIRMAN.

In November I wrote to each member of the committee asking for suggestions. Only two replies were received. Mr. J. C. Cronley's reply is submitted herewith. Mr. B. F. Bowen did not write in a form for presentation to the meeting, but he made some valuable suggestions, and I will present them, slightly modifying his language, trusting he will be there to make corrections if I have misunderstood him and to stoutly defend his views if they are assailed.

It is my opinion that our Society should not commit itself as for or against any proposed legislation. The work of the Society should be to encourage and help its members to become efficient workmen in their respective lines. There substantially the scope of the Society's work should end.

To say that the state laws do effect us is but to state a platitude, but if we are to work to effect legislation we should work as citizens and not as members of the Society. Believing thus, I still believe our meetings should be an arena where all questions may be fully and freely discussed. That I may provoke such discussion I will express opinions as to what should be brought before the legislature.

The statutes of Ohio provide for decennial appraisals of real estate, and that, with certain exceptions, that appraisal shall stand for ten years. The exceptions are that in Cuyahoga, and possibly some other counties, a board of equalization is given power to correct, if justice demands it. Another exception is made in Sec. 2797, and that section should be repealed. It serves no good purpose and works harm. When land is changed from acreage to subdivision property its value is increased by the money spent for actual improvements, including surveys and other labor. If additions were made to valuations on this account the same as for buildings, no fault could be found, but it is not that which is considered under Sec. 2797. Beyond this the recorded plat does not add to the value of land. That value is de-

termined by location and many other causes. Unless there existed an undervaluation no change could be made. Grant such undervaluation then under Sec. 2797. A, who is enterprising and opens streets and otherwise improves his property in connection with a recorded plat, is fined for doing so by having his taxes increased, while his less enterprising neighbor, B, escapes the increased tax. The results are that large tracts have been and are being sold in small lots by metes and bounds, and obscure descriptions are fastened on duplicates for an indefinite time in the future.

In place of this I would allow counties to offer inducements to men to place plats on record. Not only plats to divide land, but plats to unite adjacent lands belonging to different owners. Counties could afford to do this for the many benefits growing out of the greater simplicity of duplicate descriptions. I would have the plats made and signed by a surveyor. I would not object to having it done by a "competent" surveyor, but I would not care to have that specified in the law.

I would have the law designate what the plat should show. For instance, that sufficient monuments had been set or found, the lengths of the lines and the angles, and that these should be consistent within a specified limit of error. I would have a competent tribunal to determine whether the plat conformed with the law before it should be allowed to go to record. If later evidences should show that misrepresentations were made on the plat, I would make the landowners responsible for all damages in consequence. If monuments were not placed as represented, or if any distance was given wrong within a specified limit of error, then on complaint of any purchaser of land in the subdivision the land owner should be made to cause a re-survey even to the extent of a new plat and record, all expense so incurred to be collected from the surveyor, and if the misrepresentations on the plat were made with the knowledge of either the surveyor or land owner, they should be held criminally liable on complaint of any citizen. Such a law would be better for both surveyors and the public than any license law.

A surveyor's reputation would then be more valuable and

the advisability of employing competent surveyors would be forcibly brought home to employers. There is much poor work being done by men who could easily get a license under a license law. Let the legislature dictate how work shall be done and not who shall do it. A few additions along this line would soon work out all the good proposed by the "Torrens law," and at a much less expense.

FROM B. F. BOWEN.

I think our Society has made errors in the past by going to the legislature with questionable measures, upon which we ourselves were divided. It will be well for us to consider all questions of interest to our society and the profession generally. Sec. 2797, R. S. O., should be so amended that the county auditor should divide the net value of land into fair proportions among the lots without increasing the amount (letting the streets and alleys go to the public) and let the value so fixed remain until the next decennial appraisement. This would seem just to all parties and do no wrong to the public. The "Torrens" plan for land record and transfers may be a good thing for a young colony just commencing business in a newly discovered country, but I question the propriety of introducing that plan in our state.

It may be good in England or the provinces under entailment laws, where there are but few transfers made. In this country the transition from our present methods to the Torrens plan would prove very expensive and would mostly benefit real estate dealers, commercial agencies and other "middle men."

I am opposed to the Torrens law for the reasons above indicated.

FROM J. C. CRONLEY.

Every profession should be justly protected by law and every person engaged in that profession should be amenable to the law, thus adding dignity and responsibility to his position as well as enhancing his pecuniary considerations. One of the most serious difficulties with which the civil engineer has to contend is that the law does not give to him the same recognition it does to the lawyer, doctor or teacher. It does not require of him

either merit or skill, or establish any standard of qualifications. In fact, with the exception of ditch work and some forms of pike construction, the law does not require a civil engineer at all, either to make plans and specifications or superintend the construction of road, pike or bridge work in any county in the state (except, perhaps, where special legislation has been asked). Thus it is that county commissioners and township trustees are continually doing work that ought to be done by a competent civil engineer, robbing the profession of that which belongs to it, as well as defrauding the taxpayers of the state annually out of thousands of dollars by the very poor, unscientific class of work that is done under their supervision.

The law on this point should be mandatory. All work as above indicated should be done according to plans and specifications and under the directions of a competent civil engineer, whose duty and qualifications should be established by statute. And not only this class of work, but any other form of work that usually requires a civil engineer or surveyor, should be done by thoroughly competent persons who are legally responsible for the kind of work they do. If a civil engineer or surveyor through his incompetency or ignorance is the cause of loss or damages to other parties, he ought to be held personally responsible for the amount of such damage or loss. On the other hand, the state should guarantee to him absolute protection from non-professionals, and other classes of persons who are unqualified to pursue that line of work. Let us therefore invoke the aid of the legislature in giving to our profession the same recognition that is accorded to the doctor, lawyer or teacher. No person enters a school room expecting to follow his vocation unless he has a certificate from a board of school examiners. Neither would a person engage in the practice of either law or medicine unless he was legally authorized to do so. Yet there are hundreds of persons who attempt to do the work of a civil engineer, whose only qualification is an unlimited supply of "nerve." Let us make the duties of the civil engineer or surveyor both honorable and responsible, then ask from the state that protection which shall be commensurate with the duties and responsibilities of the

profession. To attain this end, we believe this Society ought to send a committee of not less than three persons, who shall meet the legislature at its next biennial session of 1897-8, and there, by an intelligent presentation of facts, secure such legislation as will embody the suggestions herein stated.

DISCUSSION.

Chairman Strawn: This matter has for some time been before this Society, and it is quite probable that some of you have matured thoughts upon it, which will be gladly received at this time by the Society.

Mr. Harry Gates: I will ask if the last portion of the report read was signed by the committee?

Mr. Cronley: The last was my own report. I read three reports.

Mr. Gates: I take exception to that last statement in reference to making civil engineers responsible as doctors and lawyers are. I would like to know where any lawyer is responsible for any case he loses, or a doctor for any patients he may kill. If an engineer makes a mistake, who is to decide whether he makes a mistake accidentally or purposely? It is not my idea at all that the engineer's competency ought to be measured as a doctor, lawyer or teacher's is, and then to say that he ought to be responsible for his work, which the doctor or lawyer is not.

Mr. Cronley: If a physician is guilty of malpractice he is liable to the law, and as to the lawyer, I do not know whether anything can be recovered from him or not. But I am in favor of shutting out those people who have no other interest in this profession but to get dollars and cents out of it. All I want to see is better work, and I do not want to take back anything I said.

Chairman Strawn: There is quite a material difference between the surveyor and the doctor and lawyer. The doctor can charge it all up to kind providence if his patient dies, and the lawyer knows at best he has only half a chance; but a surveyor must take all the responsibility.

Mr. Snow: Mr. Varney makes a mistake often made in regard to the placing of taxable property on the duplicate. He

says that because a man makes an improvement of his property he is fined by increasing the taxes on it. I will ask if the property on which the improvement is made is not increased in value and should not be increased in the same proportion upon the duplicate. If I bought a lot a year ago valued at ninety dollars on the duplicate, place a house on it and it is now valued at one thousand dollars, am I paying a fine?

Mr. Paul: Without going into the merits of the subject of single taxation and other economical subjects raised by the gentleman who last spoke, I will speak briefly on the point raised by Mr. Varney as to the propriety, expediency and justice, every time an allotment or subdivision of land is placed on record, for the county and local authorities immediately "jump onto it," as you might say, and increase that valuation five or six times as much as the adjoining part which is not divided. I think it is in every respect wrong, not only to the individual who suffers by reason of the increased taxation which is entirely unjust, but also it is an injury to the community by preventing proper planning and laying out of the city in advance of its growth. I think there are some laws on the statute books for the regulation of plats and the prevention of their being placed on record, which are an injury to the proper planning of towns. We ought to know long in advance of the actual occupation of territory for residence or business purposes, where streets or business thoroughfares are to be laid; and any plan by which these thoroughfares and the outline of that territory can be determined in advance of occupation is public benefit. In that respect I think the city of New York has been very much in advance of any city in the United States, if not in the world. There has been, somewhat in advance of its growth, a fixed plan which the city must take. Now, we have our platting commissions, we have our schemes of numbering, means to prevent people from putting things on record, and a tax commission to step in and prevent what is a most desirable thing to do. I think some surveyors of this state have been misled on that subject, and that their progress has been in this direction, somewhat like the crab's, backwards.

Now, it is only a question of propriety in regard to licensing

surveyors. I may say this. I think that the tendency of the times is all in one direction. There is not a trade or profession or a calling but is taking some means to organize itself to protect its interests and incidentally the interests of the community. It is not altogether a new thing. In all cities of the old world, extending back many years and centuries, it has been the custom for all trades and callings to organize themselves into guilds or organizations for their own protection. And it is a historical fact, which every student understands, that the progress of the different arts and sciences has been furthered by these organizations. With that tendency, I think the surveyors as a body cannot but fall in line. We find within a few years all the medical societies and all the druggists, the dentists and apothecaries, dispensers of pills and powders and the prescribers of them, and all sorts of trades and professions are seeking to place these restrictions upon outsiders. I think with this tendency so manifest, we scarcely need argue it at length. It is a tendency which will force itself onto us in spite of ourselves. I think the surveyors, as much as any, need these protections. It will be for their good and for the good of the community. In statutory legislation of various kinds, the engineer should be recognized explicitly as a member of the community and fit to take charge of certain works, and should be named in specific enactments.

Several years ago I was called on, in connection with some viewers appointed by certain authorities, to lay out a road. I discovered that I was simply a servant of the viewers. In the selection of the road I had no volition or choice. My duty was simply to mark out a road which certain individuals might designate. It so happened in this particular instance that they were three men of unusual skill and capacity, and in many ways as competent to lay out that road as I was, and in many ways their selection was almost an ideal one. But I have seen a good many cases where the knowledge of such matters was very limited.

And that leads me to the matter spoken of here, that is the recognition of the engineering profession on the state board of health. That should be very properly partly in charge of physicians. But there was a question on the subject asked here this

afternoon which ran to engineering. It is not merely a question of health, but circumstances and expense. Northern Ohio is underlaid to a large proportion with limestone rock extending down, perhaps an indefinite distance. Above that is a tough, tenacious clay. Under those circumstances, the subject of sewage disposal has an entirely different significance than it does where the subsoil is open, gravelly, sandy or loamy. I think in the consideration of all these things, the profession of engineering should be recognized. As a matter of course, we elect a lawyer as judge; but I have known instances where a man has been elected even county surveyor who had never set up an instrument.

I think it is time that we assert ourselves in this matter, and in so doing we shall be only following in line with the tendency of the times, which, if it does not sweep us older men with it, will certainly catch the younger ones. For my part, I am ready to take part in the new movement, and as long as I live and practice the profession, I would like to keep up with the progress of the times.

C. N. Brown: I would like to say a few words in regard to this matter of licensing. It seems that a number of surveyors in the state have quite a wrong idea of it. The idea I have held in regard to it is that in order for a man to be elected to the office of county surveyor or city engineer, it ought to be necessary for him to know how to read and write, at least. As the law now stands, he need not know even that, and it seems a disgrace to the community.

Professor McFarland could name instances in which men have been elected county surveyors who, as Mr. Paul says, had never set up an instrument. We have had a man come to us at the Ohio State University who did not know a compass from a chain, who had never worked with a surveyor and had only the commonest country school education, but who was of the proper political color and, through influence, had secured the nomination, which, he assured us, in his county amounted to the same thing as an election. He somehow had a feeling that there was something he did not know, and he came over to learn the whole matter in two or three weeks. He went away and never has been

back since; but I suppose he was elected, because nomination in that place meant election.

Now, I do not think we ought to ask a great deal, but I think something ought to be required. That in order to qualify for the office of surveyor, a man ought to pass an examination before a board appointed by the Governor, in such subjects as plain trigonometry, plain land surveying, statutes of the state relating to the surveyor and his duties, possibly some few things like that. I don't think we ought to start out by asking much more than that. An examination in these branches before a board of practical men, and the proof of one or two years of practical experience as an apprentice—carrying the rod, driving stakes and helping in the office—such requirements seem not too much.

In regard to the expense, I would make it very light, as an outside limit, not over five dollars; and when once the certificate is obtained, there is no further expense, as in case of doctors. I don't think it would be wise to attempt an annual fee or tax.

These are my ideas which I have talked over with a number of engineers, or surveyors; and I think this Society ought to stand for something of that kind.

Mr. Huston: I am glad to hear Mr. Brown's statement. I think the general feeling exists that this license business is a scheme to shut out everyone except those who had received three or four years' technical education. If the word shall go out that the examination is simply to be a practical one, it will make a great difference. But I assure you that in our part of the state the opinion prevails that it is simply a scheme of the universities to shut out everyone except those who have a technical education; and when that idea is gotten rid of, a good deal of opposition to licensing will be done away with.

C. N. Brown: Nothing was farther from my mind than such an outcome. I don't care where, when or how a man gets his information, so he has it. Many surveyors have obtained their knowledge by working under practical surveyors. No doubt many such men have become competent engineers. In regard to the State University—I speak of that because I know of

it, and I presume the same is true of the others—at the Ohio State University, we do not pretend to make finished surveyors; but we do give the young men as much theory practice as we can. We do not expect to send a man out to be chief engineer of a railroad or city engineer of a city after he is six months out of school; but we do recommend them to under positions, unless they have had, during their college course, more than usual practical experience. I think everyone will admit that land surveying cannot be learned out of a book alone. The examination might consist of two parts, one on book work and the other on practice—give a man an instrument and see if he can do the work.

Mr. Gates: I was on the Legislative Committee a couple of years and this question was wrangled over considerably. No conclusion could be arrived at that would suit all classes of engineers. One branch would object to anything proposed by another. The bill that was presented to the last legislature provided for the expense of maintaining the board to be borne by the engineers. I do not see why there should be any great expense in maintaining the board. As the examination of engineers of the United States is made by officers of the army, I do not see why in the same way the examination of applicants in the state could not be made to devolve upon some officers in the state.

Another point: The Secretary speaks about the standing of the surveyor who has not a collegiate education. I have not had much expression from that class in this city, but among the engineers in this city the opinion is prevalent that an examination made so simple in order not to bar out these men of less education will not avail them anything. They say such an examination would not be of any benefit to us, but would give a man of very little experience and who has nothing in his business, as much of an advantage in business as we have ourselves. Now, for instance, some have gone to work and made plats and records, kept everything in good shape in our offices and intend to follow the business all our lives. Another man steps in here who has a license, but who works a while in one place and in another and has not had much experience, and having a license may get a

good deal of work. We would be placed on the same level and there would be no reason why they should not get as much work as engineers or surveyors of an established business. Therefore, I cannot see, for my part, what benefit it would be for a man of established business.

Mr. Judson: In answer to the objection Mr. Gates has raised, I would like to ask this question: What protection has the surveyor or engineer anywhere at the present time? If his trade is liable to be interfered with, or his business injured by one licensed man who might come in, is it not much more liable to be interfered with at the present time because any man can buy an instrument and go to work if he can find anyone to employ him? It seems to me that the main point from which we want to work in favor of the license to surveyors is no primarily on the ground of the benefit to result to the surveyor himself; but the benefit to the public. Physicians are not licensed because it is primarily a good thing for them, but as a protection to themselves and the public generally. It seems to me that the same thing ought to apply to the engineer who is intrusted with a large amount of work which involves a great deal of property and money, and if competent, might cause a great deal of trouble. It ought to be urged upon the broad ground of protection to the public, and secondarily to the engineer himself. There is no question but there are a great number of incompetent men elected to the office of county surveyor. I have in my mind an instance where a man was elected county surveyor in a neighboring county, and came to me a few days after his election and asked me how to use a transit. He did not know anything about it. I know of another instance relating to road surveying. The law requires that a skillful surveyor shall be employed to assist in laying out the road. In this case a man was employed who knew nothing about it; he did not have an instrument and knew nothing about using one if he had had it. One other thing in regard to the objections raised by those who are at present practicing engineering: The bill now before the legislature, as I remember it, adopted by the society a year ago and practically in line with one previously adopted by the Society, provides that one who has practiced two

or three years shall not be required to take the examination. The idea is that we must make a step and though it may not be a very great one, it will be one in the right direction. We have got to do these things gradually. The standing of the profession in the eyes of the public is so low that the steps at first must be small and after that the progress must be as the standing of the profession will admit.

C. N. Brown: At the risk of tiring the members, I would like to say a few more words, in answer to Mr. Gates. Let us compare the first-class doctor or specialist with the young fellow just graduated. Both have the right to practice. You might compare one with the civil engineer with years of experience, who has accumulated a valuable library, maps, notes, etc., who has a knowledge of certain corners, certain particular experience, and says he has a license. Some young fellow comes along who works part of the time surveying, part of the time teaching school, cutting corn, etc., and he has a license. The first, you say, has no protection. Take the specialist physician, the aurist, oculist, what protection has he from the young physician just out of school? Both must pass the examination, they must know a certain amount of things—a certain amount of anatomy, a certain amount of materia medica, etc.—and must have a diploma from a college of a certain standard. Take the lawyer of years' of experience, what protection has he from the young fellow who has just passed the bar? Simply, the people will not hire him. The state simply says that a man must know certain things before he can have the privilege of competing with him who is well equipped.

In our own case, we must go slow. If a man has practiced two or three years, he should be given a license without examination; and the law ought not to go into force for two or three years after its passage so as to work no hardship. The examination should be made so that a young man of average brightness would be able to pick up in a year or two, if he worked hard, all the theoretical knowledge required.

The proposed bills which have been talked over have all been burdened with another class of matter which, it seems to

me, should be left off—regarding fees and certain work which the licensed surveyor may do and the other fellow cannot. The less said about that the better. I think it would be better to start out mildly, for instance, and simply say that no man may be elected county surveyor or city engineer who has not a license. I would not say anything about the fees, simply leave it that way, and I do not believe there would be much objection to a law of that kind. I don't think it will help any one to any great extent, but it will help matters in the next fifteen or twenty years. I think much good would come from it.

Chairman Strawn: This matter came up about ten years ago in this society; and I think Mr. Brown, in his last remarks, has struck the keynote to the failure to secure anything for the surveyor thus far, when he says that the difficulty has been that attempts always have been made to define what constitutes a survey. A person needs to know something more than to be able to take a yardstick and measure off what amount is called for, and it seems to me that we should commence first by establishing a standard for standard workmanship. Let one of those classes be for county surveyors; let another be for city engineers; let another class come under the head of railroad engineers, or ditch engineers, and I have seen in our county some very strong evidence of the need of bridge engineers as well, for I know of a few bridges in our county which, if twice as long, would break down of their own weight. In one case I asked the engineer what rule he had for figuring out the strain sheet for an iron bridge, and he replied: "I haven't any; I try to put in enough iron to make them stand." That one stood, but I am candid in saying that one of those traction engines would have crushed that iron bridge, because it would scarcely carry its own weight.

I have been before the legislature a number of times in various matters, and I will say that when you take anything before that august body they must always amend it. We had a bill before the legislature which had been passed upon by Judge Thurman and found to be all right. So it went before the legislature in good shape, but the committee thought it was the proper thing to amend it and they made it so ambiguous that

it was practically inoperative. The difficulty is that it is pretty difficult to disabuse the mind of the average voter, and especially the average politician of the suspicion that surveyors of the state are fishing for something which they ought not to have. We must not try to make the law cover too much. I feel confident that we cannot be too careful to get the law specific, and at the same time not to cover every little thing that anybody with any brains or skill at all can do.

Professor McFarland: I wish to add a word. The perfect freedom existing in this state as to who can be elected county surveyor was very beautifully illustrated in a case which came under my notice. The man who was elected had never gone as far as the "rule of three," never set a compass, had never heard of a sign, tangent or cosign, did not know how to find the area of a square—but he was elected to the office all the same. He concluded that the needle pointed to the north and all the lines were three and a half degrees apart. He did not make his computations, but brought them to me to be done. He paid no attention to the course at all, just said it was so long or so broad. After a while he went down to survey a line a half mile long and he charged ten dollars for it. I asked him what he was doing, and told him that he ought to look into what the law said about charges. It had not occurred to him that there was any limitation. Afterwards he brought me some other pieces to compute, and I said to him: "George, I shall not compute any more of these, because I doubt very much whether they are accurately run, and if they are not right, people will find fault and you will say, 'Oh, McFarland did it,' and I do not propose to stand security for it any longer." He had the good sense to resign. That is the kind of people we may and do elect in the great State of Ohio as county surveyors. I commend Mr. Brown's idea as being in the right line. I think surveyors generally a pretty honest set of fellows.

Mr. Paul: I understand this subject has been before this Society a great number of times, and I fear that in the efforts to pass exclusive legislation of this kind you have endeavored to cover too much ground. I am somewhat of a believer in a re-

publican form of government; and I can see in a great many ways there would be difficulty in restricting just what kind of officers the people might elect. I fancy it would be very possible that you would run against a snag in trying to restrict the liberty of choice of the people.

C. N. Brown: Can you elect a man prosecuting attorney who is not a lawyer?

Mr. Paul: I do not propose to answer questions categorically at this time; I am simply pointing out what might be an objection to some people. But I do think we might proceed on a somewhat broader line and require that before a man can do practical surveying at all there should be some standard prescribed and that standard should be prescribed by the profession itself. The law cannot fit all contingencies; it must be left largely with the board of examiners appointed, and they will almost of necessity be of the class of men who are progressive and attend the meetings of this society. Now, I am not a university man; I never had the good fortune to graduate at any of these institutions, and from the contact I have had with them, I am not afraid of them at all. What I am especially afraid of is the new crop of incompetents—the old ones are going to die some day. We must bear with them the best we can, but admission of new ones can in a measure be controlled, and we can control that best in the same way that other professions are doing who have license system—by a board chosen from our own membership.

Mr. McKay: I think the society could with propriety ask for legislation in regard to the monumenting lines and require surveyors who are not county surveyors to file records with the county surveyor for reference; and I think such a request would have weight, if it came from this Society.

SOME OF THE BENEFITS OF OUR ENGINEERS' ASSOCIATION.

E. B. OPDYCKE, PULASKI.

Clearly do I recall, as if on yesterday, the first meeting of our small band of surveyors in an office in the Capitol. The names of a few of those with whom I then met are still fresh in my memory. A portion of these are still on the list as members for this eighteenth annual meeting. I presume that my attendance at that first meeting, from the northwest corner of our state, was actuated by the same impelling need that moved the others to attend, viz., a co-operation with members of like profession, mutual instruction in our work, and a more intelligent discharge of our duties.

Fortunately, the success of our meeting encouraged us to organize, and the eighteenth annual meeting is placing itself on record. As in the case of all organizations which have a legitimate purpose in view, our Association has been of incalculable benefit to its members; and the benefits have even been diffused beyond the limits of membership—have been enjoyed by many outside.

When first entering upon the discharge of my humble duties in the seventies, I felt the urgent need of such information as has since been evolved in our different sessions. I realized a special need of equipment in the law of reference to the re-establishment of lost corners in fractional, as well as in full sections, and for making apportionments in drainage cases. My wants were many, but the wherewith to supply them were not, within my knowledge, to be found. As a consequence, I stumbled along in the dark. When my method was correct, my work was right; when incorrect, it was erroneous. In a word, errors were made by me which I deeply regret, but which I cannot efface. Possibly, a few others are in the same unfortunate condition. I could present a case which was adjudicated upon by the Common Pleas Court in reference to the re-establishment of a lost corner on a township line, in which an er-

roneous method, whether in the light of law or of common sense, was employed by the surveyor. Such error appears to have been discovered neither by the opposing counsel nor by the Court, and the plaintiff, who should have won, was the losing party in the case.

Soon thereafter, in assuming the duties of the office of County Surveyor, I was selected to re-locate the road on the new line. I was requested by the winning attorney to visit the surveyor of the new line and to receive instructions as to the proper method of making the survey. I complied with the request, and, though increasing the number establishing the erroneous corner, I surely gave it not an ounce weight of authority, so far as justice is concerned. To mention a few other errors made in my virgin efforts would be alike mortifying to myself and unprofitable to others. How different might it have been had the advantages of surveyor's organizations been at my hand when first I assumed the duties of the office! Not even a code of instruction could I find, which the State Secretary was by law required to furnish. It was simply a groping in the dark, trusting the dictates of common sense, right or wrong, with no chance to remove the excrescences of error by exchange of views with those of like calling.

Rapid progress toward the adoption of correct methods of making surveys has characterized our Association—a progress far more rapid than could have been achieved without it. As a consequence, the public has been better served; and at a time as much too late as these advantages have failed to be enjoyed.

For the establishment of the interior corner of a section, two methods had been employed. First, by the bisection of the measurements from opposite corresponding quarter corners. Second, at the intersection of straight lines from these corners. The results were widely different in many cases.

Lost section corners were also restored by various methods with very important difference of results.

In one of the earlier Ohio Reports of our Association the committee on land surveying, in answer to the question where a lost quarter-corner on a fractional section, adjoining a township

line, should be restored, replied, "At forty chains from the section corner," throwing the fraction on the north and west. At the next meeting I urged a reconsideration of the question so that our Association should place itself on record in line with the true method. This it did. The Michigan Association, a year previous, had pronounced itself in line with the true method, viz., a pro rata measurement.

During an intermission at one of our earlier meetings I was bestowing words of praise on the transit for accurate and rapid surveys. But in the little knot of surveyors with whom I was pleasantly discussing the matter, there were those who maintained the superior merits of the compass with plain sights —not one of whom was outspoken for the transit. How many in our Association today could be found who would prefer the compass to the transit, except possibly for some work of minor importance?

Only a few years ago the magnetic needle, its declinations and variations, were seriously discussed at one of our sessions. It was recommended that the necessary observations be made by surveyors in every part of our State at certain fixed times, and results reported to the committee on surveying, so that a true science of the needle might be established, and to the end that increasingly accurate surveys could be made by its use.

In the course of the discussion, however, each one contributing thereto evolved more and more the light which led Professor McFarland, of such gentlemanly demeanor, to exclaim that the members were "accumulating a mass of information which was simply overwhelming" (words to that effect)—information which tended to show that little or no weight could attach to the needle for the degree of accuracy which our day required; so that a discussion of its merits was hardly worth the time consumed to the practical surveyor. What surveyor gives more than a second place, at best, to the magnetic needle in making surveys?

For many years I have rarely even dropped the needle in making surveys, but have relied almost wholly upon the vernier and limb of the transit. When, by inquiry, the uninitiated

chanced to learn of this, it was amusing to behold the look of astonishment. Is it prudent thus to inform the curious inquirer? Does not the fact, made public, strip us of that dignity which the magical power of the needle has been wont to confer upon us?

Though the physician could very often dispense with his physic and set his patient on the road to convalescence by advising him to pursue a certain hygienic course, yet would he not soon be without a patient? Be it so. I shall, nevertheless, not worship at the shrine of the needle beyond its curiosity in science.

I have not, however, set out the huge task of the advancement of our Association in each branch of surveying and engineering. Besides the very valuable reports of our Association, there are the exchange reports of like associations of several other states and of Canada—all of which are highly interesting and instructive. Well advanced, indeed, is the surveyor and engineer who cannot glean from these reports many points of great value to him in his practice.

One of the most valuable contributions to the surveying fraternity is Francis Hodgman's Manual of Land Surveying. Its author, realizing the practical needs of the profession, and being encouraged by some of the state associations of surveyors, has, in this manual, given the profession a work of more value than the text-books on surveying in general use. It should be an essential part of the outfit of every practicing surveyor. Every one contemplating the practice of surveying should first fully familiarize himself with its contents.

There is also to be highly prized the acquaintances and friendships made at these meetings. These will be recalled with pleasure and will not be forgotten.

Every surveyor and engineer in Ohio who is in practice and who takes pride in his profession, and who desires to keep abreast with every advancement made by the profession, should become an active member of the Ohio Association.

DISCUSSION.

Mr. Gilpatrick: I would like to ask if there is such a thing as a code of instructions furnished by the Secretary of State?

Mr. Brown: Yes, sir.

Colonel Innis: I would like to ask whether the Secretary of State knew anything about it when he made it?

Mr. Brown: The Secretary of State did not make it.

Chairman Strawn: I will say that the gentleman who was the compiler of that code is not present. Mr. Bowen, one of the first members of this Society, was employed for that work; and the present code, which was approved, as I understand, by the Secretary of State, was prepared by Mr. Bowen.

Mr. Cronley: Taking the latitude and longitude of Columbus, what is the variation of the magnetic needle?

Colonel Innis: The last time I took it, it was 29 minutes. That was, I think, about two and a half years ago.

Mr. Cronley: Which way does it point?

Colonel Innis: It now points a little west of north.

Mr. Cronley: That is my idea about it. I think in our county it points about ten minutes east—that is Allen.

Chairman Strawn: It is only a short time since Columbus stood in the line of no variation.

Mr. McKay: In our county, Greene, it is 40 minutes east of the true meridian. The line of no variation is between here and Xenia.

Mr. Brown: In Pickaway county, observation taken the 30th of last month, it stood about 55 minutes to west. Speaking about a code of rules, we have one published by the state, and there is one issued by the Department of Interior of Washington last October, which is better than any other.

Mr. Cronley: You mean from the land office?

Mr. Brown: Yes, sir.

Chairman Strawn: I think there are few people who speak now of "as true as the needle to the pole," unless it is the [illegible].

Mr. McKay: Do surveyors generally use the needle to measure angles?

Chairman Strawn: All who depend on the needle, raise their hands? (No hands are raised.) There do not appear to be any.

(A similar question being asked as to how many had used the needle, response was made by three members.)

Chairman Strawn: That shows that young blood is now in the business and they do not regard the needle as trustworthy.

(Colonel Innis stated that when he and Mr. Kinnear first started in the business such a thing as a surveyor's transit had not been made. Mr. McKay thought the needle had its uses in some sorts of work, but found difficulty on account of the general use of wire fencing on the farms now, this affecting the needle. Mr. Cronley finds use for the needle in running ditches and has experienced no bad results from its use.)

THE TRIANGLE.

WHAT IS IT? AND WHAT ITS RELATION TO MATHEMATICAL SCIENCE?

JONATHAN ARNETT, LONDON.

A triangle is three lines, each intersecting the other two, inclosing an area. The lengths of the sides, their quantity of divergence at points of intersection and the inclosed area, form seven magnitudes; three sides, three angles and an inclosed area.

Of the six magnitudes, three sides and three angles, if three are given, one being side, the other three can be computed.

As regards shape, any triangle will belong to one of four classes, namely: Right angle triangle, equilateral triangle, isosceles and scalene.

The right angle triangle has one right angle; the equilateral triangle has its three sides equal and, perforce, its three angles equal; the isosceles triangle has two sides equal, and perforce, two angles equal; the scalene has its sides and angles unequal.

Triangles are further classed as plane and spherical. The writer will devote a short while to the consideration of some of the properties of the plane triangle.

The sines of the angles of any triangle are proportional to their corresponding sides, and conversely.

According to the sacred historian, when the fiat went forth, "Let there be light," the creative energy was triangular: Father, Son and Holy Ghost. Ever since the newly created "stars sang together, and all the sons of God shouted for joy" all along adown the path of time, throughout universal nature, the creative, transforming and upholding triangular energies are seen.

Let the eye turn where it will, or wander where it listeth, everywhere it is met by stress supported by triangular forces, whether in motion, erect or prone.

The mobility of the living is triangular; it stands erect amid balanced triangular forces, and lies prone in death upon a like support.

See those two fleet horses on the track yonder, contending for a prize. See how, with almost lightning speed the hind feet

are brought forward. See! the horse's body, hind and fore legs have assumed a rough approach to the equilateral triangle, to pass, instantly in mid air, through the isosceles, right angle and highly scalene, to be when the fore feet touch the ground as instantly brought into position for a second leap. This action of the horse, the animal, is a marvel of marvels, but so often witnessed it passes with the common coins. The horse, by slow combustion in nature's laboratory, consumes his daily ration of grain, hay and water, and its pent-up energy is, by nature, stowed away in his muscles to be by him expended in manipulating his triangles of motion.

The heat is intense. Let us seek the cool and grateful shade of yonder woodland. Let us seat ourselves by this giant oak, monarch of the hills. See how his body, as it approaches the ground, expands in size, spreading out at the ground into a large base of roots thrust deep into the earth. Suppose a storm prevailing from the West. What force does this oak employ to hold himself erect? All his body west of the central neutral axis as right angles to the storm is subjected to a tensil stress, while all of his body east of the same axis bears a corresponding compressive stress; and since the adhesion of the wood fibres resist motion among themselves, his semi-axis becomes a rigid lever arm, the third side of the triangular resistance to the topling of the tree. In this way the oak weathers the storm, encouraging, by his example, a like resistance of the subjects of his domain to their common enemy.

The heat has abated. Let us pass over the river upon yonder bridge. We will pause here a few moments and witness how nicely an assemblage of triangles makes a continuous highway by bridge viaduct for the wayfarer, while the seething, foaming turbulent waters rage beneath.

We will suppose the first bridge erected here consisted of squares and rectangles on pin centers. The builder believed that squares and squares only were wanted. His bridge refused to do his bidding and fell. The arch was without a key. Squares and rectangles cannot transmit stress. The bridge we are now passing over has a stress carrying system of triangles whose mem-

bers bear to the abutments the variable stresses of our weight as we go forward—a moving load. Everything else being equal, the greatest carrying capacity is secured when the system of triangles is equilateral.

It is eventide—and the last repast of the day, to promote digestion, must be masticated, if teeth are present, by triangular forces.

See the clock, by six triangular strokes, announces the quitting time. Muscles of high-labored triangular tension relax and the expectant stomach is ready for the evening meal, while the clock continues by triangular swing to beat the rythmic measures to the tune of fleeting time.

The sun in flaming glory has passed behind the western hills and timid stars, that throughout the day had withdrawn from his august presence, sally forth. The air is balmy, the evening serene, we will pass out. Here on this rustic seat you can, by triangular suction, enjoy your Havana, while we survey our surroundings. Cast your eye upward and see those mysterious, glittering, heavenly hosts as they rise, mount up to the zenith, then glide adown the western sky to their setting. What are those mysterious bodies, and what the outcome of their daily journeyings? The simple-hearted shepherd of old asked himself this question as he tended his flock by night; contemplating these mysterious bodies, saw God in them and became the better man. The shepherd was the pioneer astronomer, the first to adore the Builder of all and the first to hear the world-thrilling angelic shout, "Glory to God in the highest, and on earth peace, good will toward men."

See yon flaming star as he travels up the eastern sky. That is the planet Mars. On account of his bloody vesture he was dignified with the name, Mars, after the god of war. Mars journeys in an orbit 144,000,000 miles from the sun. The path of orbity of Mars, therefore, lies exterior to that of the earth, and his periodic revolution but forty-three and a half days short of double that of the earth.

The sleepless eye of the astronomer, when Mars rose in the east as the sun set in the west, took his disc measurement 17" 1,

and again when Mars set with the sun, or as near thereto as Mars could be seen for the sun's brightness, the same astronomer made a second disc measurement of 7″ 4. Here the omnipresent triangle tells us the distance of Mars from the sun, his diameter and time of periodic revolution.

Turn your eye westward and see yon bright planet that illumines the western sky. That planet was named Venus in honor of the voluptuous goddess of love and beauty. She is called an inferior planet because her orbit lies wholly within that of the earth. That same indefatigable star gazer, the astronomer, when she looked her fairest and most lovely at her inferior conjunction between the earth and sun, made her disc measurement of 59°6 and again at her superior conjunction with the sun between Venus and earth, a disc measurement of 9″6. The triangle here, mounting the witness stand, testifies that Venus is 68,000,000 miles from the sun; has a diameter of 7,687 miles, and waltzes around the sun in 224.7 days.

The orbit of Venus is inclined to the ecliptic at an angle of 3° 23½′, so that a transit of Venus, at inferior conjunction, across the disc of the sun, can only occur when Venus is at or near one of her nodes.

Here again we find our man ready to make triangular measurements of the movements of this beautiful planet. He notes the instant contact of the discs of Venus and sun, the progress of the planet across the sun's disc and the instant that transit ends. Here again are triangular data to verify other result , and that no doubts may remain he subjects all to the crucial tests of Kepler's second and third laws, that the radius vector of a planet in motion sweeps over equal areas in equal times, and that the squares of the periodic revolutions of the planets are proportional to the cubes of their distances from the sun.

The tireless mathematician has run a system of triangulation throughout the solar domain. He has weighed the earth in a balance, and calling the earth's weight unity, with it he has compared the weight of all other members of the solar family. He observed the friendly disposition of Uranus, causing him to

diverge from his path of duty to exchange greetings with, to us, an unknown planet. He noted the time and place when and where this deviation occurred, and employing planetary laws already established, computed the distance of the unseen stranger from the sun, his time of revolution and the point in space a telescopic search would find him, steadily obeying the solar behests.

Here is an achievement of the triangle that eclipses conception. That two men (Leverier and Adams) with the mere history of the solar system spread out before them, in glancing over the habits of the planets and particularly the erratics of Uranus.

From a study of the history of the solar system they found that at a certain point and time Uranus had broken away from his orbit and struck out into space as though he had taken it into his head to quit the solar domain and go into business for himself, after this swerving from his path of duty as though he desired to make the acquaintance of some fair one whose calling led her in a line of duty exterior to his own.

This is enough. These men, from their knowledge of the properties of matter, knew Uranus would not leave his orbit except in obedience to a cause, and that that cause must be the existence of a mass of matter in space exterior to his line of travel. Here are the data. These men grapple with their problem. A solution is reached, and the point of the whereabouts of the stranger in space determined. So confident of the correctness of their findings, and having no telescope, they write an astronomer of another nation requesting him to train his telescope so many degrees bearing and distance from a certain fixed star and he would see a new planet. It is done. There, within less than one degree of the point named, the planet Neptune is seen.

So far the work of the triangle is unbaffled. The mathematician is not content. His triangulations, run upon the solar domains, have become commonplace. His triangle and investigations must be put to greater test. So he essays now, with his triangle, to lasso yon fixed star. To do this, where can he secure a base of sufficient length? He has got it: he takes the major axis of the earth's orbit, which in round numbers is about 200,-000,000 miles.

On the 21st of December the earth at perihelion passage, with instruments of great precision and exactness, he takes the bearing of his star and its relation to some of its principal neighbors, and follows up these instrumental measurements daily until June 21, and the earth at her aphelion passage. The result of all this vigil satisfies him that the parallax of the major axis of the earth's orbit subtends an arc at the star, if any, less than 1″. Assuming that the semi-diameter of the earth's orbit 100,000,000 miles subtends 1° of arc at the distance of the sun from the star, what is the distance of the star from the sun?

The natural sine of 1″ of arc to radius unity is ·0000048481368, and its artificial sine 4.685575.

Two lines diverging from the star toward the sun with a quantity of divergence of 1″ would separate a little less than 485 miles in traversing 100,000,000 miles, and to separate 100,000,000 miles, the semi-diameter of the earth's orbit, these lines, the equal sides of an isosceles triangle, must journey a little more than 20,618,556,700,000 miles. My reader, are you lost? The writer is.

On gentle wing let us return from our dreary flight among the stars to earth, to continents by oceans bounded, and triangulate the shore lines of sea and national boundaries; anchoring our stations upon mountain summits and islands in the sea.

Our coast surveying has been done with a high degree of exactness. At close of a system of triangulation run over 500 miles, a suitable base is computed and then measured, differing less than an inch.

By surface triangulation, by observations made upon sun, moon and stars, aided by the clock of time; by observed solar and lunar eclipses, the geography of the earth's surface will be as complete, comparatively, as our door yards.

The triangle, by steady swing, counts the moments of time into the coffers of the past; the earth, by triangular force, turns to the sun when he reaches in dazzling glory high twelve at noon, and high up in the belfry of the sky, by a like force, the clock of time sweetly chimes low twelve at night.

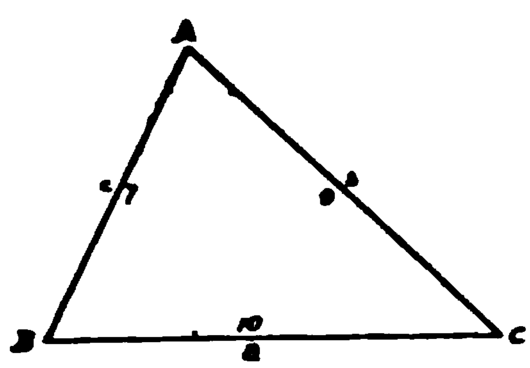
Thus we find the triangle linked hand in hand with mathe-

matical science from the very pedestal of its capitol up to its topmost arch which it supports by triangular key.

First: Let it always be remembered that the writer attempts the demonstration of no theorem, or proposition. The geometer has worked over the triangle as long as he could find pay dirt.

Second: Let it be further remembered that the writer has drawn together from his works on geometry the figures and formulas herein given, drawing liberally upon the work of A. H. Welsh, A. M., of Columbus High School, published in 1878.

Third: Let it also be remembered that the sides of the triangle A, B, C are: A=10, b=9, and c =7, and mapped to a scale of 4 to the inch; and that the angles, worked by the formula of the corallary to theorem 1.



$\text{Cos.}=\dfrac{b^2+c^2-a^2}{2ac}$ gives natural cosine of angle.

Thus $\text{Cos. A}=\dfrac{b^2+c^2-a^2}{2bc}=\dfrac{30}{126}=\dfrac{5}{21}=$Nat. Cos. 0.238095.

Thus $\text{Cos. B}=\dfrac{a^2+c^2-b^2}{2ac}=\dfrac{68}{140}=\dfrac{7}{35}=$Nat. Cos. 0.485714.

Thus $\text{Cos. C}=\dfrac{a^2+b^2-c^2}{2ab}=\dfrac{132}{180}=\dfrac{11}{15}=$Nat. Cos. 0.733333.

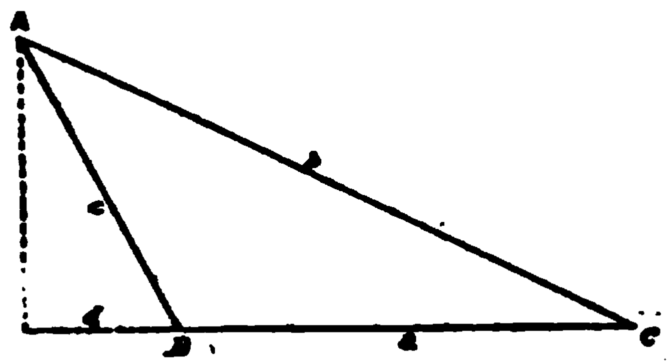
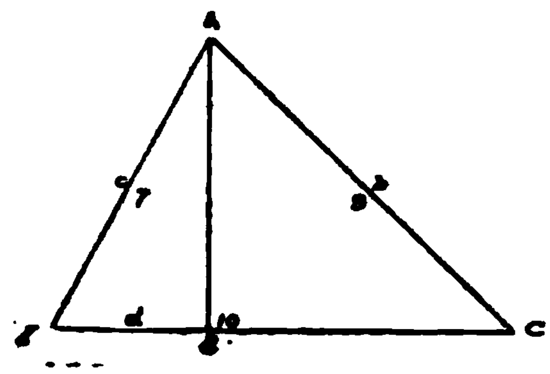
Now, the reader can convert the foregoing natural cosines of the angles A, B and C into artificial cosines by adding 10 to the characteristic so as to render the characteristic of the logarithm of the natural cosine *positive.* The natural sine or cosine of an angle is a decimal and therefore its characteristic is always negative. Thus:

Angle A, 76° 13′ 33″ nat. cos. 0.238095 log. $\bar{1}.376750.$
Add characteristic of 10, 10.
This gives cos. A=76° 13′ 33″= 9.376750.

Angle B, 60° 56′ 27″ nat. cos. 0.485714, log. $\bar{1}.686380.$
Add characteristic of 10, 10.
This gives cos. B 60° 56′ 27″= 9.686380.

Angle C, 42° 50′ 0″ nat. cos. 0.733333, log. $\bar{1}.865302$.
Add characteristic of 10, 10.
This gives cos. C 42° 50′ 0′= 9.865302.

So always remember that the natural functions of an angle can be converted into artificial functions by adding 10 to its characteristic.

Theorem I. The square on any side of a triangle is equal to the sum of the squares of the other two sides, minus twice the product of these sides into the cosine of their included angle.

First, if the angle B is acute we have $b^2=a^2+c^2-2ad$ cosine B; if angle B is obtuse we have $b^2=a^2+c^2+2ad$ cosine B. But in the first case, d=c cosine B, and in the second, d=c cosine (180°—B), and by substitution we have

$$b^2=a^2+c^2-2ac \text{ cosine B.}$$

And in second we have
$$b^2=a^2+c^2+2ac \text{ cos. } (180-B)$$
$$= a^2+c^2+2ac \text{ cos. } (-\text{cos. B})$$
$$= a^2+c^2-2ac \text{ cos. B.}$$

Cor.: From this theorem, by transposing, we get the cosine of any angle of a triangle. Thus 2ac cosine $B=a^2+c^2-b^2$. Divide both sides of equation by 2ac and we have cosine $B=\frac{a^2+c^2-b^2}{2ac}$. Performing the work here indicated gives cosine $B=\frac{100+49-81}{2\times7\times10}=\frac{68}{140}=\frac{17}{35}=0.485714=$ natural cosine of B. (See above.)

Hence, the sides of a triangle being given, we can compute the cosines of the angles.

Theorem II. The sine of half an angle of a triangle is equal to $\sqrt{\frac{(\frac{1}{2}S-b)(\frac{1}{2}S-c)}{bc}}$.

Theorem III. The cosine of half an angle of a triangle is equal to $\sqrt{\frac{\frac{1}{2}S\,(\frac{1}{2}S-a)}{bc}}$.

Theorem IV. The tangent of half an angle of a triangle is equal to $\sqrt{\frac{(\frac{1}{2}S-b)\ (\frac{1}{2}S-c)}{\frac{1}{2}S\,(\frac{1}{2}S-a)}}$, which is, as it should be, the the sine of half the angle A, divided by its cosine.

The formulas of theorems 11 and 111, above, are derived directly from the formula, cosine $A=\frac{b^2+c^2-a^2}{2bc}$, to the corollary to theorem 1, and are rigidly true. The sides $a=10$, $b=9$, $c=7$, $\frac{1}{2}S=13$. Let us examine the formula.

$$\sqrt{\frac{(\frac{1}{2}s-b)\ (\frac{1}{2}s-c)}{bc}}$$

What does it mean? It means that the square root of the quotient of (13—9) (13—7) divided by 9×7 is the natural sine of half the angle A. Thus:

$\sqrt{\frac{4\times6}{9\times7}}=\sqrt{\frac{8}{21}}=\sqrt{0.38095238095238}=0.6172133=$ the natural sine of half the angle A, which=38° 6′ 46.5″ and double this gives angle A=76° 13′ 33″. The artificial sine of half the angle A can be obtained thus: The formula reduces to $\sqrt{\frac{8}{21.}}$

Now by logarithms divide by 8×21.		1.322219
Thus: log. divisor 21,	a. c.	8.677781
" " dividend 8,		0.903090
		9.580871
		10.000000
Add 10 to characteristic of this and		2)19.580871
divide the sum by 2, extracts the square root=		9.790435

So 9.790435 is the sine of half A, 38° 6′ 46.5″.

And multiplying 38° 6′ 46.5″ by 2 gives A=76° 13′ 33″ as before.

Now let us see how much juice we can express out of the formula to theorem 111 for the cosine of half A. The

formula reduces to $\sqrt{\frac{13\times3}{9\times7}}=\sqrt{\frac{13}{21}}=\sqrt{0.619047619047\dot{6}2}=$ 0.7867958=the natural cosine of half the angle A=38° 6′ 46.5″ so angle A=76° 13′ 33″ as before.

Since the formula, $\sqrt{\frac{(\frac{1}{2}s-b)\,(\frac{1}{2}s-c)}{\frac{1}{2}s\quad(\frac{1}{2}s-a)}}$ is the expression for the tangent of half the angle A, and since it is the natural sine of half the angle A divided by its natural cosine, we can obtain the natural tangent of half the angle A by dividing 0.6172133, the natural sine of half of A by 0.7867958, the natural cosine of half A. Thus: $\frac{0.6172133}{0.7867958}=0.7844644=$ natural tangent of half angle A.

Let us make a flank movement upon tangent half of A and capture it by logarithms. The formula

$$\sqrt{\frac{(\frac{1}{2}s-b)\,(\frac{1}{2}s-c)}{\frac{1}{2}s\quad(\frac{1}{2}s-a)}}\text{ reduces to }\sqrt{\frac{4\times6}{13\times3}}=\sqrt{\frac{8}{13}}.$$

Now, as we have been using radius, unity, if we use the radius of table which is 10000000000 we must use log. 10, and if we put it under the radical we must use 20, radius².

If we assume a radius equal to the square root of 13, then the square root of 8 will be the tangent to half the angle A to the same radius. And if we wish to compare the tangent $\sqrt{\frac{8}{13}}$ with the table of artificial sines, cosines, etc., we must use 10000000000, which is the radius of that table, and to put it under the radical we must square 10000000000. So to obtain the square of the tangent we state as

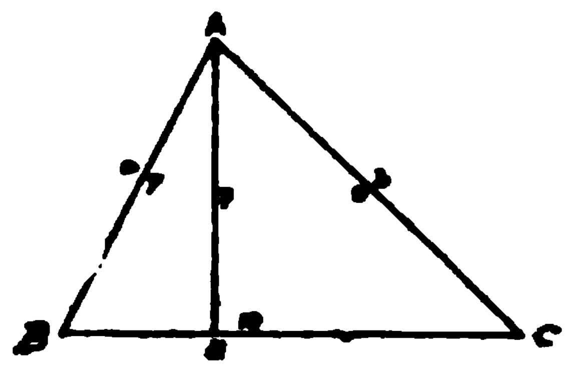
$$\sqrt{13} : \sqrt{8} :: \sqrt{100000000000000000000} :$$
$$\sqrt{61538461538461538461.53846}$$

The log. of this last term is 19.789147, and dividing by 2 to extract square root gives for tangent ½A=9.8945735.

This shows that the triangle is well nigh omnipresent. It is simply the comparison of the like parts of similar triangles.

Theorem V. The area of any triangle is equal to half

the product of any two sides into the sine of their included angle. This is a broad proposition.



Let A, B, C. be the triangle.

Then its area=$\frac{1}{2}$ap.

But p=c sine B.

Therefore area A, B, C=$\frac{1}{2}$ ac

sine B=$\frac{10\times7\times0.87411763}{2}$

=30.5941171.

0.87411743=natural sine of angle B.

3d. Area =$\frac{a^2 \text{ sine B sine c}}{2 \text{ sine A}}$=30.5941171.

4th. Area=$\sqrt{\frac{1}{2} S \left(\frac{1}{2}S-a\right) \left(\frac{1}{2}S-B\right) \left(\frac{1}{2}S-c\right)}$=equals the square root of the product of the numerators of the sine and cosine of half the angle A.

5th. Area=$\frac{1}{4}S^2$ tan. $\frac{1}{2}$ A tan. $\frac{1}{2}$B tan. $\frac{1}{2}$C.

6th. Area=$\frac{1}{2}$S into radius inscribed circle.

7th. Area=the continued product of the sides divided by twice diameter circumscribing circle.

8th. Area=$\frac{\frac{1}{2}p^2 \text{ sine A}}{\text{sine B sine C}}$

Reader, don't you think mathematics have illy treated the triangle by giving so many ways to burglarize its treasury?

Theorem VI. The area of a triangle is equal to $\sqrt{\frac{1}{2}S \left(\frac{1}{2}S-a\right) \left(\frac{1}{2}S-b\right) \left(\frac{1}{2}S-c\right)}$. Now, from this let us get, if we can, the sine of angle A. To do this we have area of triangle=$\frac{1}{2}$bc sine A. But sine A=2 sine $\frac{1}{2}$A cosine $\frac{1}{2}$A, and

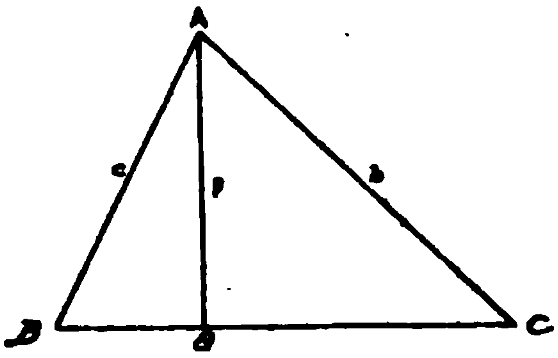
$$\text{sine of } \tfrac{1}{2}A=\sqrt{\frac{\left(\frac{1}{2}S-b\right)\left(\frac{1}{2}S-c\right)}{bc}}$$

$$\text{and the cosine of } \tfrac{1}{2}A=\sqrt{\frac{\frac{1}{2}S\left(\frac{1}{2}S-a\right)}{bc}}$$

multiplying twice the sine of $\frac{1}{2}$A by its cosine we get the sine of A=$\sqrt{\frac{\frac{1}{2}S \left(\frac{1}{2}S-a\right) \left(\frac{1}{2}S-b\right) \left(\frac{1}{2}S-c\right)}{bc}}$. That is, the sine of A=twice the area of the triangle divided by the product of its including sines, and is another way of asserting that the sine of any angle of a triangle into the product of its

adjacent sides equals twice the area of the triangle. So, if you have the sides, compute its area and divide twice this area by the product of any two adjacent sides, gives the natural sine of the included angle.

Theorem VII. Any side of a triangle is equal to half the sum of the sides into the sine of half the opposite angle divided by the product of the cosines of the adjacent half angles. A rigid, direct and lucid demonstration of this theorem gives the formula, side $a=\frac{\frac{1}{2}s \text{ Sine } \frac{1}{2}A}{\cos \frac{1}{2}B \cos \frac{1}{2}C}=\frac{1}{2}S$ tan $\frac{1}{2}A$. Either of these formulas will give side BC. From which the sides may be determined when their sum and the angles are given.



Theorem VIII. The perpendicular from any vertex of a triangle to the opposite side is equal to that side into the product of the sine of the adjacent angles, divided by the sine of the sums of those angles.

For $p=b$ sine C, and sine A: sine B: :a:b $\therefore$ $b=\frac{a \text{ sine } B}{\text{sine } A}$

Therefore $p=\frac{a \text{ sine } B \text{ sine } C}{\text{sine } A}=\frac{a \text{ sine } B \text{ sine } C}{\text{sine } (B+C)}$.

Problem I. Given the three sides of a triangle to find the radius of inscribed circle.

$\frac{1}{2}r\,(a+b+c)=\frac{1}{2}rs=$area, and Radius da,

by theorem VIII, $=\frac{a \text{ sine } \frac{1}{2}B \text{ sine } \frac{1}{2}c}{\text{sine } \frac{1}{2}\,(B+C)}=2.3533936.$

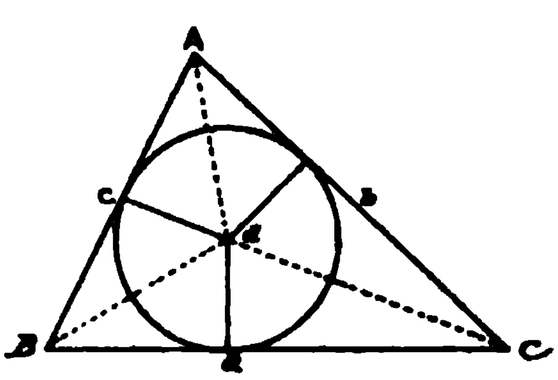
But area of triangle A, B,C$=\sqrt{\frac{1}{2}s(\frac{1}{2}s-a)\,(\frac{1}{2}s-b)\,(\frac{1}{2}s-c)}$

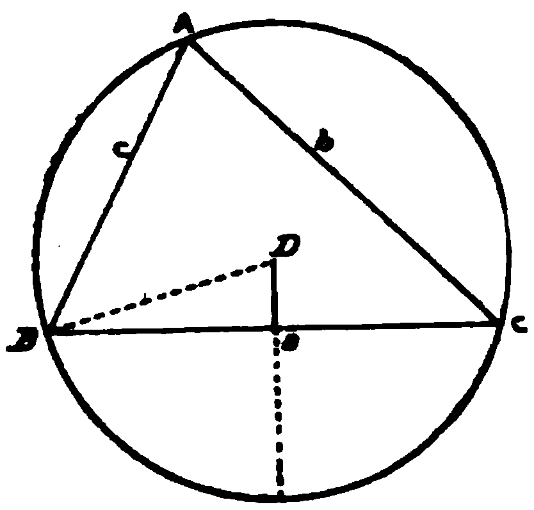
Therefore $\frac{1}{2}rs=\sqrt{\frac{1}{2}S\,(\frac{1}{2}S-a)\,(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}$.

Hence, $r=\frac{\sqrt{\frac{1}{2}S\,(\frac{1}{2}S-a)\,(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}}{\frac{1}{2}S}=\frac{\text{area}}{\frac{1}{2}S}=$

$\sqrt{\frac{(\frac{1}{2}S-a)\,(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}{\frac{1}{2}S}}=2.3533936.$

Problem II. Given the three sides of a triangle to find the radius of the circumscribed circle. The angle D=the angle A, since each equals $\frac{1}{2}$BC. The $\frac{1}{2}a=r$ sine D=r sine A.





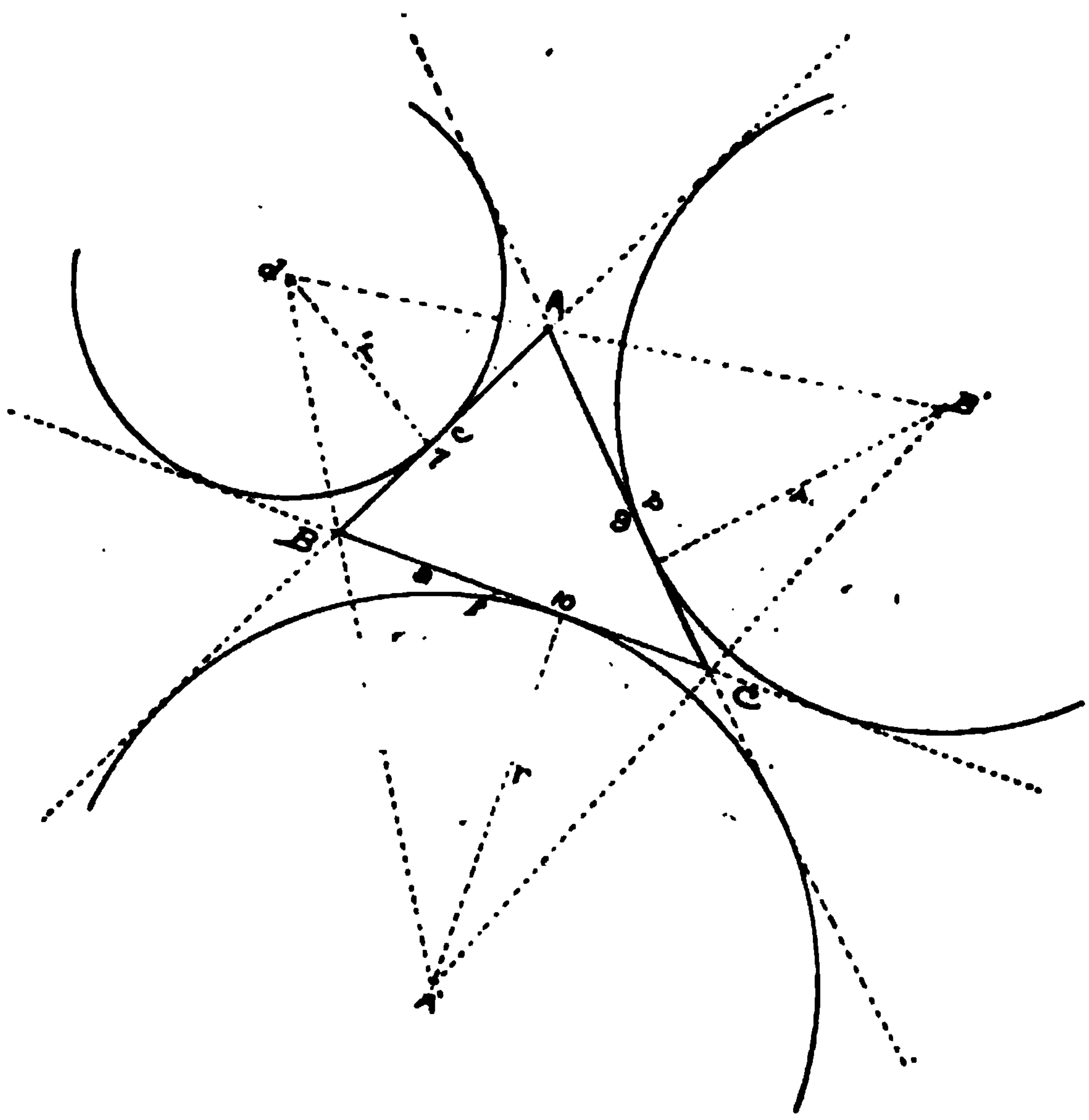
$$\therefore\ r = \frac{a}{2 \text{ sine } A}$$

$$= \frac{a}{\dfrac{4\sqrt{\frac{1}{2} S\,(\frac{1}{2}S-a)\ (\frac{1}{2}S-b)\ (\frac{1}{2}S-c)}}{bc}}$$

$$= \frac{a}{\dfrac{4 \text{ area}}{bc}} = \frac{abc}{4 \text{ area}} = 5.148.$$

A nat. cos.	0.2380952	Ar—	9376751	A	76° 13′ 33″
B " "	0.4857142	"	9686381	B	60° 56′ 27″
C " "	0.7333334	"	9865302	C	42° 50′ 0″

Problem III. Given the three sides of a triangle, to find the radii of the escribed circles. An escribed circle is exter-



ior to the triangle, tangent to one side and the other two sides produced.

Computed radii—r—on a=10.1980390.
r′—on b= 7.6485293.
r″—on c= 5.0990196.

By theorem VIII

$$r=\frac{a \text{ sine } \frac{1}{2}\,(180^\circ-B)\,(\text{sine } \frac{1}{2}\,(180^\circ-C)}{\text{sine } \frac{1}{2}\,(360^\circ-(B+C)}$$

$$=\frac{a \text{ sine } (90^\circ-\frac{1}{2}B)\,(\text{sine } (90^\circ-\frac{1}{2}C)}{\text{sine } (180^\circ-\frac{1}{2}\,(B+C)}$$

$$=\frac{a \cos \frac{1}{2}B \cos \frac{1}{2}C}{\cos \frac{1}{2}\,(B+C)}=\frac{a \cos \frac{1}{2}B \cos \frac{1}{2}C}{\cos \frac{1}{2}A}=\tfrac{1}{2}S \tan \tfrac{1}{2}A.$$

The first and second formulas above refer to the triangle $A'BC$; the third and fourth formulas refer to the triangle ABC using the cosines of the half angles of A, B and C, which are the sines of their corresponding complements in the exterior triangle $A'BC$. Reader, is not this pretty? How nicely we compute the parts of the exterior triangle $A'BC$ by the use of the functions of the half angles of the triangle ABC. Mr. Triangle, $A'BC$, is not aware that we know anything about whether he has a large bank account or stands mortgaged for his worth. Let us say nothing to him about, "where ignorance is bliss, it is folly to be wise."

We will now discuss the last formula above$=\frac{1}{2}S \tan \frac{1}{2}A$, and see if we can't express some nectar out of it. Remember the expression $=\frac{1}{2}S \tan \frac{1}{2}A$ is the same as the first formula given below in a modified form.

Therefore $r=\frac{1}{2}S\sqrt{\frac{(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}{\frac{1}{2}S\,(\frac{1}{2}S-a)}}=\sqrt{\frac{\frac{1}{4}S^2(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}{\frac{1}{2}S\,(\frac{1}{2}S-a)}}$

$=\sqrt{\frac{\frac{1}{2}S\,(\frac{1}{2}S-a)\,(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}{(\frac{1}{2}S-a)^2}}=\frac{\text{area}}{\frac{1}{2}S-a}$. Reader, let us see if we can get the successive steps taken in the last four formulas above. Above we had $r=\frac{a \cos \frac{1}{2}\,B \cos \frac{1}{2}C}{\cos \frac{1}{2}\,A}=$ $\frac{1}{2}\,S \tan \frac{1}{2}\,A$. Then that being true, gives us

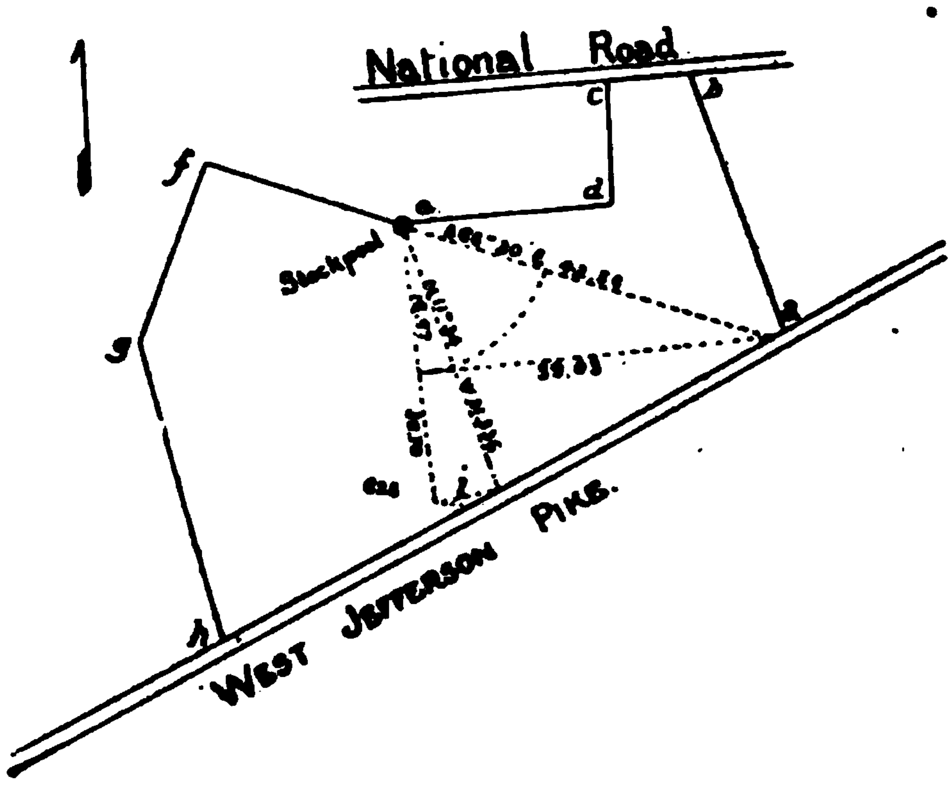
$r=\frac{1}{2}\,S\sqrt{\frac{(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}{\frac{1}{2}S\,(\frac{1}{2}S-a)}}$. Now, by squaring $\frac{1}{2}$ S and putting it under the radical we get the second formula:

$r=\sqrt{\frac{\frac{1}{4}S^2\,(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}{\frac{1}{2}S\,(\frac{1}{2}S-a)}}$. Next by multiplying both numerator and denominator by the denominator, we get

$r = \sqrt{\dfrac{\frac{1}{8}S^3\,(\frac{1}{2}S-a)\,(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}{\frac{1}{4}S^2\,(\frac{1}{2}S-a)^2}}$. Now, divide both terms of this fraction, the $\frac{1}{8}S^3$, coefficient of the parenthetic part of the enumerator, by $\frac{1}{4}S^2$, the parenthetic part of the denominator, and we get $r = \sqrt{\dfrac{\frac{1}{2}S\,(\frac{1}{2}S-a)\,(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}{(\frac{1}{2}S-a)^2}}$.

Next extract root gives $r = \dfrac{\sqrt{\frac{1}{2}S\,(\frac{1}{2}S-a)\,(\frac{1}{2}S-b)\,(\frac{1}{2}S-c)}}{\frac{1}{2}-a}$

so $r = \dfrac{\text{area}}{(\frac{1}{2}S-a)}$. So you see the radius of either escribed circle is equal to the area of the triangle divided by the half sum of the sides diminished by the side on which the circle stands.



ab,	N	11° 5′	W	30.63	chains.
bc,	S	88° 45′	W	7.88	"
cd,	S	7° 10′	W	14.42	"
de,	N	86° 30′	W	23.30	"
ef,	N	71° 30′	W	22.87	"
fg,	S	27° 7′	W	18.72	"
gh,	S	7° 55′	E	34.74	"
ha,	N	67° 15′	E	69.59	"

Problem. From the above survey, abcdefgh, containing 223.30 acres, draw a line from the stock-pool at e to the West Jefferson pike, to part off to the East 96.18

acres. To do this first tabulate the courses, distances, latitudes and departures of above survey from a to e. The differences of the latitudes and departures will give the latitude and departure of the closing course and distance ea. Now, compute the closing course and distance ea.

To compute the closing course, ea, state

		1229682
as difference of latitude	16.97	ac. 8770318
is to difference of departure	39.03	1.591399
so is radius	90°	10000000
to tangent of course ea	66° 30′ 3″	10.361717

Next compute the distance ea=42.56 chains.

		9.962401
Thus as sine of the course	66° 30′ 3″	a. c. 0.037599
is to radius	90°	10.000000
so is the departure	39.03	1.591399
to the distance ea,	42.5596	1.628998

Next tabulate and compute the land you have inclosed in your survey abcdea, equal to 41.59 acres, leaving 54.59 acres yet to be parted off.

Next from your closing course, S 66° 30′ E and the course of the West Jefferson pike, N 67° 15′ E, reduce the angle eah, 46° 15′. Now since the area of any triangle equals half the product of the sine of the angle into its adjacent sides, and since the area 54.59 acres yet to cut, is a triangle, and since we have the included angle 46° 15′ and one of the adjacent sides 42.56 chains we can obtain the other side along the West Jefferson pike by dividing twice the area 54.59 by the product of the sine of 46° 15′ into the given side 42.56 chains, thus:

	log.	9.858756
	"	1.628998
sine 46° 15′	= a. c.	0.141244
log. 42.56	= a. c.	8.371002
2×54.59 acres=1091.8 sq. chs.		3.038142
35.513 chs.		1.550388

So you see we must measure S 67° 15′ W from a on the West Jefferson pike 35.513 chains to i to get 54.59 acres

more land. Next to get course and distance from i to e at stock pool:

Thus latitude and departure of ea	S 16.97	E 39.03
On pike " " " " ai	S 13.73	W 32.75
	S 30.70	E 6.28

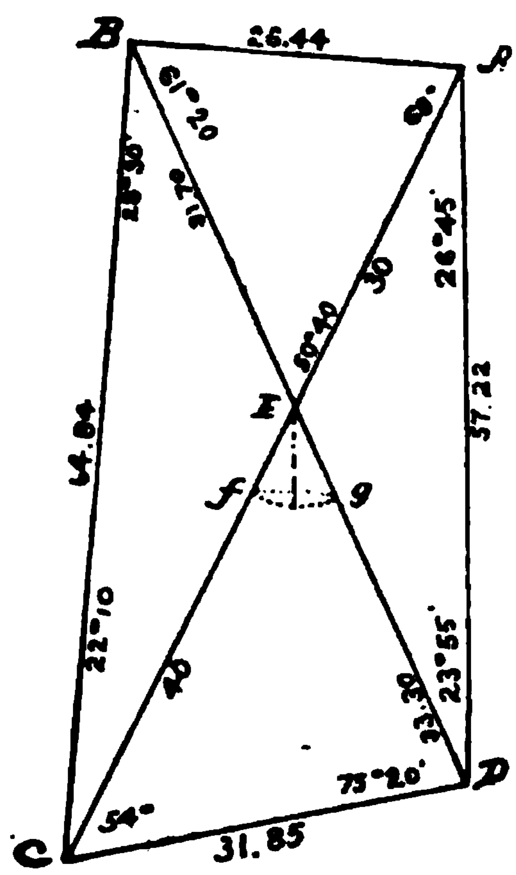
This gives for the difference of latitude of the course and distance ie 30.70 chs and 6.28 chs. and to compute the course state

		1.487138
lat. 30.70	a. c.	8.512862
Dep. 6.28		0.797960
Radius 90°		10.000000
Long. of course 11° 34′		9.310822

For the distance ie square the latitude and departure and extract the square root of their sum gives about 31.336 chains.

The reader will see the differece of departure is 6.28 chains E., so the course and distance to the stock pool must make 30.70 chains N. and 6.28 chains W. N. 11° 34′ W. 31.336 chains.

Problem 5. This is a desperate case. The surveyor went to the house of the owner of the annexed tract of land on other business, not as surveyor. While there, the owner wanted the surveyor to measure the quantity of land in the figure A, B, C, D. The surveyor had with him his field book and pocket table book, and in his buggy a 100-ft. tape and set of marking pins. The owner, an ax and plenty of help. The sides cannot be measured on account of obstructions. Each corner can be clearly seen from its diagonal corner and the diagonals can be well measured.



Reader, under the circumstances, what would you advise the surveyor to do? Set up a flag staff, each, at A and B. Now, from C line in a stake and tack it a foot or so on each side the intersection of the

diagonals at E. Do the same between D and B by stretching a twine string between tacks in each pair of stakes, drive and accurately tack stake at intersection of the diagonals A, C, and B, D. Now what? In range with tack at E and staff at A, drive and tack a stake at F, 100 feet toward C, from tack at E. In like manner tack a stake 100 feet toward D from E. What next? Measure distance, very accurately, from tack at f to tack at g, equal to a shade less than 85.577 feet. Now what? Divide 85.577 feet by 2 =42.7885 feet. Next, divide the 42.7885 feet by the 100 feet measured on the diagonal, equals 0.427885. What is this 0.427885? It is the natural sine of half the angle at E, and searching in your table of natural sines you find it is the sine of 25° 20′ the double of which, 50° 40′, is the angle E; the natural sine of 50° 40′ is 0.7734716. The next step? Measure nicely the diagonals, C, A, and D, B, 70 and 65 four pole chains respectively, noting distances from C and D to tack at intersection of diagonals at E, 40 and 33.30 chains respectively.

Next. Multiply natural sine of 50° 40′ by the product of the diagonals 70 and 65 chains and divide the product by two gives the area of the figure A. B. C. D. thus:

$$\frac{0.7734716 \times 70 \times 65}{2} = 1759.64789 \text{ square chains} = 175.964789$$

acres. If our work is exact the above is the exact area.

Reader, don't you think the triangle to the surveyor is a pole star? By latitudes and departures he computes his surveys, by latitudes and departures he computes his whereabouts on life's seas, and by the latitude of old age and longitude of time, he can closely estimate the point at which he will meet the icy river that separates his surveys of probation in this life from the surveys of fruition he will make upon the other shore.

SECTION LINES AND COUNTY BOUNDARIES.

PROF. R. W. M'FARLAND, OXFORD, OHIO.

The question implied in this caption should be overhauled and fully discussed. It has come up more than once, and is liable to be sprung at any time, in a number of counties in this State. In such cases the county surveyors on both sides of the disputed line, will probably be called on to execute the decrees of the court.

It is proposed in this paper to examine the question mathematically, practically, and historically.

Few terms are sooner learned by the child after he gets under the open sky, than the terms east, west, north, and south. The sun rises in the east and sets in the west,—which direction is east and which is west? The answer is soon learned.

"Once on a time" in questioning a lot of Ohio teachers, I inquired whether the sun always rises at the same point on the eastern horizon, summer and winter. One thought that it did; one was not very sure; and one had never looked to see. To that lot of treachers, "East" denoted only the general direction toward the rising sun. To a surveyor or engineer, the word has a much more specific meaning. We propose to show in what sense various legislatures of Ohio have used the terms north, south, east, and west; and what degree of departure from the strict meaning we actually find in the laws of Ohio. The importance of the question is my apology for introducing and discussing it.

The first law ever passed by any legislative body, so far as I know, concerning the division of lands into Ranges, Townships, and Sections, was enacted by the Congress of the United States, under the old articles of confederation, more than two years before the present constitution was formed. The act was passed on the 20th of May, 1785.

This act is quite long and embraces many points;—that which pertains especially to my subject is as follows, viz: "The first line running north and south as aforesaid shall begin on the river Ohio, at a point that shall be found to be due north from the western termination of a line which has been run as the south-

ern boundary of the state of Pennsylvania;"—this was the celebrated "Mason and Dixon's line,"—established about twenty years before, and about which afterwards all the blatant demagogues of the country used to howl, and that "within the memory of men still living." But to return to my quotation from the aforesaid act,—"And the first line running east and west shall begin at the same point, and shall extend through the whole territory." [Laws of the U. S. Vol. 1, p. 567.] By this latter expression you must not suppose that this east and west line was to be extended to the Pacific ocean,—for the country west of the Mississippi at that time belonged to other nations. Nor does it mean to the Mississippi,—but only forty two miles, the widest extent of land then ordered to be surveyed. This first east and west line is the north boundary of the old First Seven Ranges.

MATHEMATICAL POINTS.

A true east and west line is the arc of a small circle whose plane is parallel to the plane of the equator. The equator is a great circle. Now it is mathematically impossible for the arc of any great circle to coincide with the arc of a small circle, so much as the breadth of a hair. They can not do so even for two consecutive points. But the "Geographer," as the Surveyor General at that time was called, was required personally to set out that east and west line of forty two miles. And he did so.

Supposing the Geographer to have set his theodolite, or sight-vane compass—whichever it was—at the designated point; and that by art and skill, or else by needle and guess-work and good luck, he had fixed his sight line at right-angles to the meridian—supposing him to have had a true meridian, as he had not,—and supposing, also, that his first flag had been set in this line at a distance of a hundred feet, or a thousand feet, or any other practicable distance,—what then? Why, this,—no difference how far away this first flag was set, if placed accurately in the line of sight, it would not be in the parallel of latitude which constitutes the true east and west line.

The line sighted out is the arc of a great circle, tangent to the plane of the small circle at the starting point. At the end

of the first mile, the flag would be more than a foot to the south of the true line; at the corner of the first township, it would be more than twenty one feet; and at the end of forty two miles, it would be more than four hundred feet out of the way. Suppose the Geographer to have kept on in the same line on which he started, until he should get one-fourth of the way round the earth,—he would then be twenty eight hundred miles too far south, and would be crossing the equator at an angle of about forty degrees, and be going toward the south west. But this you might say would be getting "out of his latitude";—so it would, nobody would dissent from your conclusion.

Let us have the Geographer try again; and suppose that his first flag had been sent forward a mile, and by accident had been placed exactly on the parallel of latitude. This could be done only at the expense of the angle, which would differ from a right angle by more than two and one-fourth minutes. Even in this case, the half mile flag would be five and a half feet too far north; and should the line be prolonged, the same difficulties, as mentioned in the first supposition, would recur. In fine, a true east and west line in this sense has never been run; and it is but fair to say that it never will be; and if it were, it would not be allowed to stand. For the plane of such a line is inclined for this latitude at an angle of about forty degrees to the south of the zenith; and, consequently, the line running up the acclivity on the east side of a hill, would bear to the south; and among hills such as I find in Perry county, the line at the top of the hill would be two hundred or three hundred feet south of its position at the foot. On the west side, going down, the conditions would be reversed. The line would not run straight even over a clod; its position on the top being further south than its position at the bottom, by the whole thickness of the clod. Then a due east and west line in this sense is ruled out of the case in toto.

PRACTICAL POINTS.

Nearly all lines in Ohio were originally run with the old fashioned sight-vane compass. At that time no other kind was in use. Now with what degree of accuracy can you run a line with

such an instrument? Did you ever try? I have run hundreds of miles in this way. All of you who have used such an instrument, know that it is a very accommodating assistant, and will allow your flag to be set two or three feet on either side of the true line; and the surveyor, in order to do good work, must use his judgment as much as his compass, or his line of departure will run away with him.

For the present I say nothing about the secular variation of the needle,—the quantity by which from age to age, it deviates from the true meridian. I call attention only to the daily variation. And this changes from day to day, and from month to month throughout the year. The average for January is not the average for July. It varies every month in the year, every day in the month, and every hour in the day. These facts and many more of like import have been fully established by the observations at Toronto and elsewhere. The variation in Ohio may reach fifteen minutes in a single day. Wherefore, a line run by the same men, with the same instruments, with the same care, and with equal correctness, at eight o'clock in the morning, and at two o'clock in the afternoon, will differ eleven or twelve feet at the end of the first half mile. And all of you know that the average landowner in Ohio will not surrender his claim to twelve feet of ground without some kind of a contest, even if it is only "a discoosion wid sticks," after the manner of a Donnybrook Fair.

How many of you, practical surveyors as you are, and willing and anxious to do your whole duty, as I believe most surveyors are,—how many of you have ever paid any attention to this daily variation of the needle in your practice? What then is the prospect of getting lines laid down due north and south, or due east and west? The east and west line which the United States statute calls for, is only an approximation to the arcs of a great circle which approach more or less nearly to a perpendicular drawn to the meridian. How this approximation is made, does not come within the limits I have set for this discourse. Even the meridian determined by observations on the pole star, at its greatest eastern or western elongation, is only approximate. To see this fact, look at the methods given in Chauvenet's Astronomy for determining

the true position of a star,—corrections for refraction, for parallax, for precession, for aberration, and for whatever other things cause error. The methods there given are practiced by the United States Coast Survey.

The lines in Athens and Perry counties where I have been tracing them more or less for eight years, all vary from the true meridian by about three and a half degrees, on the average; but varying a degree or so on either side of that average. Yet in deeds and leases and mortgages all these lines, by the thousand are called north, or south, or east, or west.

In Symmes's Purchase, extending from the Ohio river northeasterly between the Miami Rivers, to a line a few miles north of the city of Hamilton, the Section, Township, and Range lines deviate about six degrees from their proper position as meridian lines and perpendiculars thereto. And the variations from this six degree error, may range as high as two or three degrees on either side. The sight of a true map of Butler county is a "spectacle for gods and men." On some of the lines, the marker in the original surveying party seems to have lost his count of "outs;" for some of the miles are twenty rods too short, others are twenty rods too long, and in a few cases the errors have exceeded fifty rods. The section lines for miles look like dog-legs prolonged for the purpose of exhibiting a few more joints. I have surveyed for more than forty years in Symmes's Purchase, and in the Congress lands to the west of the Great Miami; I have surveyed for more than eight years in the Ohio Company's Purchase, and in the Congress lands outside of that district; also in the United States Military district; in the Virginia Military District, and elsewhere; and, so far as I can now remember—and I always make a record of every line I run—I have never found a section or other line exactly east and west, or exactly north and south. Nor have I found a section line exactly a mile long. I have examined all the lines in many townships,—lines certified to by the Registrar of the Land Office to be true copies of the originals,—I have examined also for myself hundreds of lines in the Records in the Land Office here in the State House, taking the original notes which are in pencil, and I say that not one-tenth

of the lines examined make any pretense of being eighty chains to the mile. A few do so, and some of these few I have had occasion to measure;—but not one of them will hold true. Now all this wide examination of things done in the original surveys, leads to the inevitable conclusion that all the lines set out by surveyors are only approximations more or less near the truth.

HISTORICAL POINTS.

To speak in general, far more than half the county boundaries in Ohio go by range, township, and section lines, and were so ordered by legislative authority. I have examined one hundred and fourteen acts of the Legislatures of the period extending from 1797 to 1825. In due time I propose to examine the remainder, and these are relatively few compared with the number before 1825.

I begin with the county where I now work, Perry. The act to erect that county was passed December 26, 1817. [Laws of Ohio, Vol. 16, p. 26.] to take effect the first of the following March. It reads in part thus: "Beginning on the line between the counties of Licking and Fairfield, at the northwest corner of the eighteenth township of the seventeenth range, thence south with said range line to the southwest corner of the said township eighteen; thence east four sections to the northwest corner of section two, township seventeen, range seventeen; thence south with said section line to the south line of township seventeen; thence with the township line east to the southeast corner of said township; thence south on the line between the sixteenth and seventeenth ranges, to the southwest corner of section nineteen, in township fourteen, range sixteen; thence east to the south east corner of section twenty-four in the same township and range"; etc., etc., through all the fourteen lines which constitute the county boundaries.

It may be well to state that in the old first Seven Ranges, also in the Ohio Company's Purchase, and in Symmes's Purchase, the thirty six sections of a township are numbered in the follow-

SECTIONS 1st METHOD

36	30	24	18	12	6
35	29	23	17	11	5
34	28	22	16	10	4
33	27	21	15	9	3
32	26	20	14	8	2
31	25	19	13	7	1

Fig. 1

SECOND METHOD

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Fig. 2

ing way: Number one* is in the southeast corner, number two is north of one, three next north, etc., to six which is in the north east corner; then returning to the south line of the township, number seven lies west of one, then numbering northwardly to twelve; and so on; number thirty-six is in the northwest corner of the township. This was the first way of numbering the sections. The method was soon changed, and the second way which is still in use was devised. In this second method section one †

* See Fig. 1.
† See Fig. 2.

is in the northeast corner of the township, the numbering proceeds toward the west, and section six is in the northwest corner of the township; seven is by the side of six, and the numbers then run east, so that number twelve stands beside one; the next tier is numbered toward the west, going and returning after the manner of one plowing corn, back and forth, so that section thirty-six is in the southeast corner of the township, diagonally opposite to its position in the first method. Also in Symmes's Purchase the ranges run east and west; elsewhere they run north and south. The first broken strips at the south side of this land along the Ohio, are called the first and second fractional ranges; then follow the first entire range; the second entire range, etc., to fifteen. As Perry county is not in the Ohio Company's Purchase, in the description of the last line of the Perry county boundary above given, you will notice that if you describe a line as running from the southwest corner of section nineteen to the southeast corner of section twenty-four in a township where the sections ar numbered according to the second method above given, this line runs east through the whole township cutting off two tiers of sections on the south side of that township.

Like remarks apply with the same force also to all the eighteen lines which make up the boundaries of Hocking county. [Ohio Laws, Vol. 16, p. 60.] In every instance the words north, south, east, and west are made to coincide with the section lines by the very words of the statute, or by necessary implication, as has been shown in the case of Perry county. These are merely specimens of the general practice of all the legislatures which have erected counties in Ohio. Yet every one of the lines in the above two counties, Perry and Hocking, varies from three to four degrees from the true meridian, or a perpendicular thereto. The words are so plain that "the wayfaring man,"—whose intellect is not of the most brilliant order,—"need not err therein."

In the acts establishing the boundaries, I count one hundred and twenty-eight cases in which the boundaries, and the section lines and north and south all go together as meaning one and the same course.

I find in the laws of the United States from 1785 to 1804,

sixteen cases in which the terms "due north," "due south," etc., are used. In every case but one the words are applied to territory in which no lines as yet had been run. In the single exception the statute required the lines dividing the section into quarters, to be run "due north and south," and "due east and west." This last act remained in force only a very short time, it was soon repealed. There are also two cases in which the laws of Congress required the lines to "run north and south with the meridian."

In like manner as in the statutes of the United States, the laws of the Territorial legislature and of the State of Ohio, contain clauses in which the words "due north," etc., are used. There are fifteen cases. In the whole fifteen the lines were in a part of the state not then surveyed into townships. There are also two other cases within territory already surveyed, in which the words "due south" in one, and "due west" in the other are used. One line was six miles long, the other, thirty. Both of these were not long afterwards, annulled as county boundaries; and I know no way to prove whether the boundaries in the two cases followed the township lines, but I suppose they did. There is one case in which the phrase "due west" was fixed on a line already run. It is in the act of December 9, 1800, [O. Laws, Vol. 5, p. 146, etc.] establishing Fairfield county,—the same act in which the two annulled lines are given. The clause is in these words, "And running south by the said range line, between the fourteenth and the fifteenth ranges, until it intersects the northern bounary of the Ohio Company's Purchase; thence with said northern boundary line 'due west' to the northwest corner of the Ohio Company's Purchase." This sentence precedes the mention of the two lines spoken of above; and inasmuch as this "due west" is fixed on a surveyed line, and that line running about four degrees out of true, it is possible that the author of the act intended to have the aforesaid "due south" line, and "due west" line also follow the township lines. To say that he did so mean is the only fair way of regarding it.

On February 12, 1820 [Ohio Local Laws, vol. 20, p. 90.], an act was passed erecting the following counties in the order I give, towit: Van Wert, Mercer, Putnam, Allen, Hancock, Har-

din, Crawford, Marion, Seneca, Sandusky, Wood, Henry, Paulding, and Williams. Every line of every county of the whole fourteen follows township lines except where state lines are brought in on the north.

Up to 1825, seventy-three counties had been established. Since that time fifteen others have been set out; and one hundred and fifty-one of the bounding lines of these fifteen counties, as shown on large maps of Ohio, are Section, Township, and Range lines. The others are on the lake shore, the Maumee river, or other natural boundary. I have examined the acts of the legislatures, establishing nine of these fifteen counties. These nine counties embrace one hundred and six of the one hundred and fifty-one lines above referred to; and I find one hundred and five of the one hundred and six, are fixed on section lines, and all are called north, south, east, or west, according to position and direction. The remaining line will be again mentioned further on. In three cases the term "due east" is used. In two of the three this 'due east' course is fixed on lines surveyed long before. One of these is in the act to change a part of the boundary of Carroll county.* [Ohio Laws, Vol. 33, p. 118.] These are the words: "Beginning at the northwest corner of section twenty-four, township eleven, range four, thence

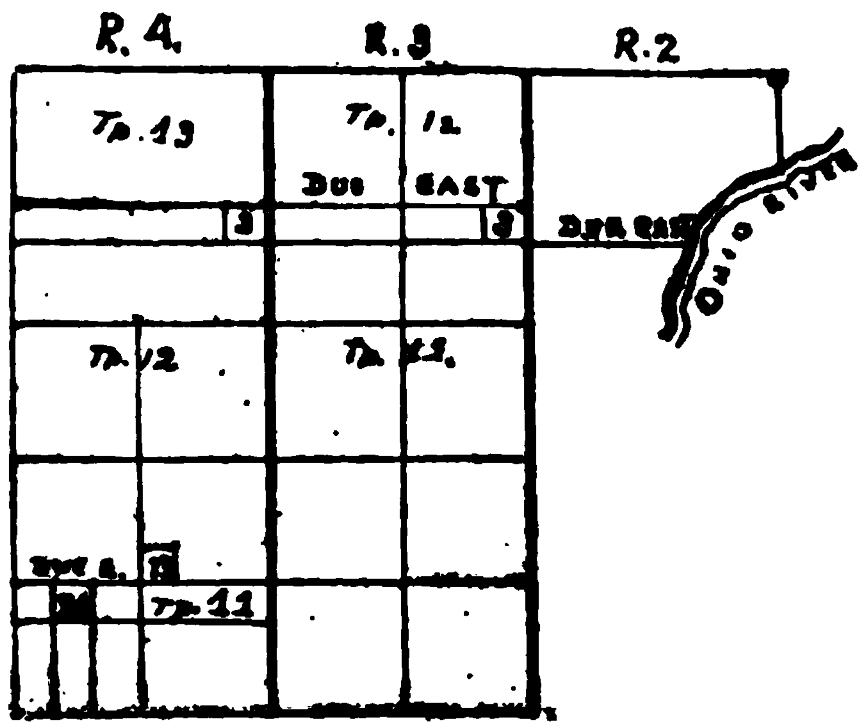


Fig. 3.

'due east' to the southwest corner of section thirteen, in township twelve, range four; thence north with said section line, six

* See Fig. 3.

miles, to the northwest corner of section eighteen, township twelve, range four; thence east, three miles," etc.

In another act changing the boundary line between the counties of Columbiana and Jefferson * [Ohio Laws, Vol. 31, p. 8], the term "due east" occurs twice. The act says: "Beginning at the northeast corner of section three, township thirteen, range four, thence "due east" six miles, to the northeast corner of section three, in township twelve, range three; thence south one mile to the southeast corner of section three; thence 'due east' to the Ohio river." The first "due east" is fixed on an old surveyed line; the second "due east" line is four miles long, and the south line of that tier of sections at the time, 1832, was

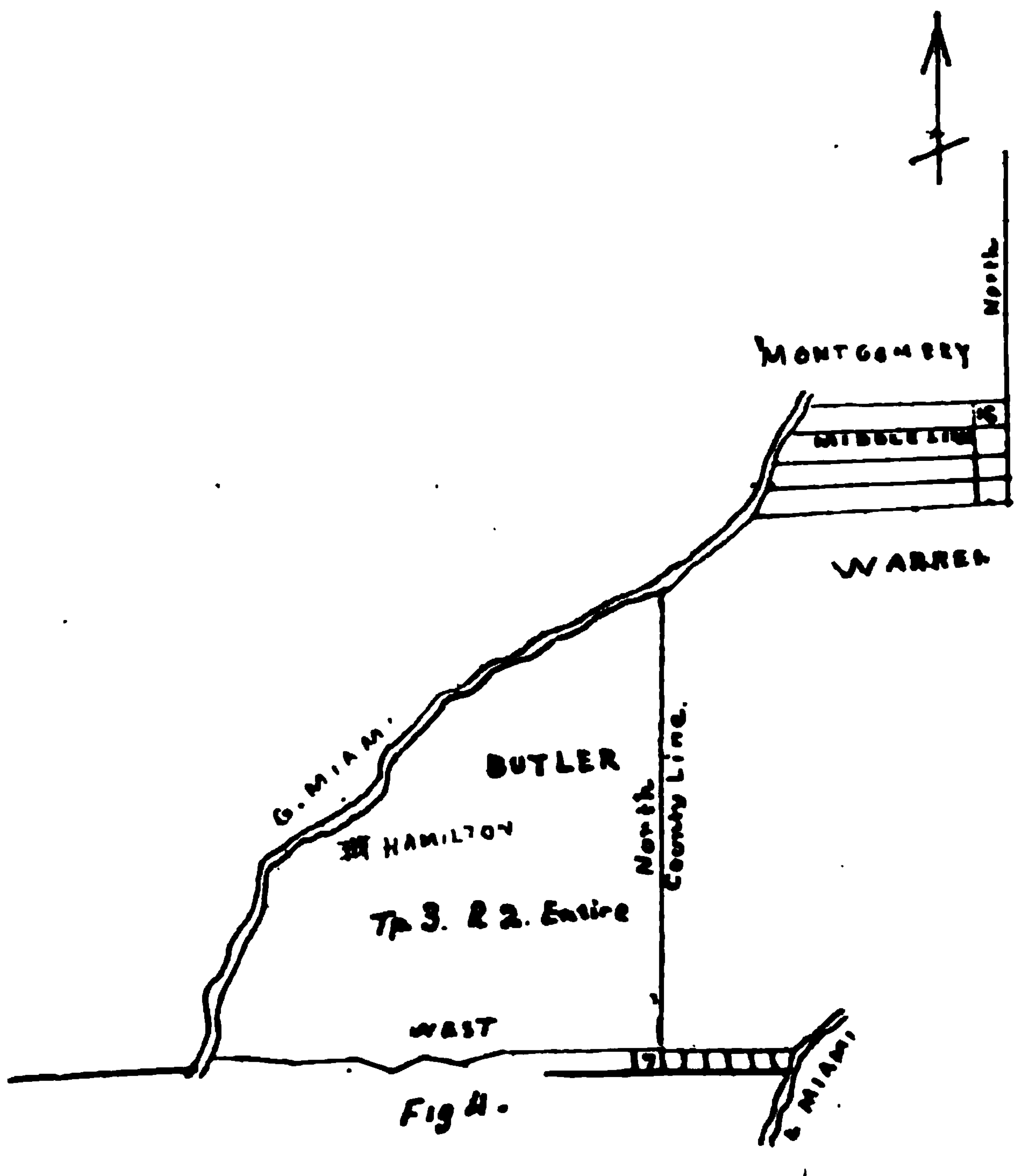


Fig 4.

made the boundary, and it so stands undisputed to this day.

It is a universal principle of exegesis, whether in law, in politics, in history, or in theology, that all parts of a document are to be interpreted according to the same rule. It is

* See Fig. 3.

not allowable to explain one part by one principle, and a like part by some other and different principle. I think, therefore, that when the legislators in one clause, said "due east," and in the same sentence fixed that direction on section lines, in so many words, that two lines farther on, in the same sentence, when they again said "due east" they meant to follow the section lines as before. This, therefore, hardly seems to be an exception to the rule, which is applied in all other cases.

I have not had time to examine the forty-five lines of the remaining six counties; but there is no reason to suppose that they will differ from the three hundred and fifteen lines already examined, and all of which completely harmonize.

We come now to the lines between Montgomery and Greene, and between Butler and Warren.* On the 24th of March, 1803, only six weeks after the final steps had been taken toward admitting Ohio as a state in the Union, the Legislature passed an act erecting four counties in the order here given, to-wit: Warren, Butler, Montgomery, and Greene. In describing the boundaries of Warren, we find these words, "Running thence west * * * * to the Little Miami; thence up the same, with the meanders thereof, to the north boundary of the first tier of sections in the second entire range of townships in the Miami Purchase; thence west to the northwest corner of section number seven, in the third township of the aforesaid range; thence north to the Great Miami; thence up the same to the middle of the fifth range of townships; thence east to the Ross county line."

Now this west line from the Little Miami runs on "the north boundary of the first tier of sections," to the northeast corner of section seven, in township three. Township four is east of three, and at this designated line, it is about four miles from the river to the corner of township three; so going west one mile from the corner, the line running north cuts off one tier of sections on the east side of township three aforesaid. Where it says "thence east to the Ross county line," it was understood

* See Fig. 4.

to be the middle line through the whole range. It was so interpreted at the time the boundary was fixed on that middle line, and so stands today.

In the same act in describing the south boundary of Montgomery county, the following words are used, to-wit: "Beginning at the northwest corner of the county of Butler, thence east with the lines of Butler and Warren, to the east line of section sixteen, in the third township and fifth range; thence north eighteen miles," etc. Now this description of the south boundary of Montgomery, fixes definitely the north boundary of Warren to be the middle line of range five, no difference how far this line may vary from the astronomical or true east. For the west end of this north boundary of Warren is fixed by the statute, in so many words, at the middle of range five on the east bank of the Great Miami. The south boundary of Montgomery is explicitly declared by the statute to be the north boundary of Warren; and the south boundary of Montgomery runs "east," so the statute says, to the east line of section sixteen, in the third township and fifth range. This distance is about ten miles. In all the cases examined in the state, where a section is named, it is included in the territory so described. This brings section sixteen in Montgomery county; it was so placed in 1803, and it stands so today.

In the description of the south line of Butler, the words are these: "Beginning at the southwest corner of the county of Warren, running thence west to the State line." But the township lines on opposite sides of the Great Miami do not tally; neither do the section lines, wherefore the above description is bad; it lacks definiteness. It caused confusion along the line between Butler and Hamilton, the people on the west side of the river more especially being uncertain in which county they lived. To remedy this defect, in less than five years from the date of the act erecting the counties, a supplementary act was passed defining more particularly the line of separation. This act is under date of January 20, 1808. The words are plain, and it is impossible for any sane mind to mistake their meaning; here they are: "Beginning at the southwest corner of the county

of Warren, and at the northeast corner of section number seven, in the third township in the second entire range of townships in the Miami Purchase; thence westwardly along the line of said tier of sections [but the act had said nothing about a 'tier of section'—that expression was in the original act of 1803] to the Great Miami river; thence down the Miami river to the point where the line of the next original surveyed township strikes the same; thence along said line to the western boundary of the state."

The distance down the Miami so expressed is about half a mile. This line so marked out has been the boundary ever since. It clearly appears, therefore, that in settling definitely the north line of Warren county and the south line of Butler, the words "east" and "west" are fixed on the courses shown by the section lines, for the description says so, in so many words; and yet these section lines in some places deviate more than ten degrees from the true east or west, and in all places, six degrees or more. In describing the line between Warren and Butler, and between Montgomery and Greene, the word "north" is used in both cases; and is used in immediate connection with the word "west" in one case, and "east" in the other; and both of these courses are shown directly by the words of the statute to mean the direction as shown by the section lines. Shall the word "north" have another method of interpretation forced on it? It is only plain, common sense to say that no member of the Legislatures which passed these acts ever supposed that the term "north" should be interpreted in a manner different from the way they had in disposing of the words "east" and "west." It would be contrary to all principles of just interpretation, as already stated. If this is the right conclusion, then the old east boundaries of Butler and Montgomery were put where the Legislature manifestly intended them to be put, and where they stood unchallenged for nearly a century.

The suits which have been instituted in these two cases, were not originated by misapplied intelligence and knowledge of the facts which I have brought before you today, but rather by misapplied ignorance, to call it by no harsher name.

In like manner some years ago, somebody tried to stir up

strife between Ohio and Indiana on account of the dividing line possibly deviating slightly here and there from the true meridian. But astronomers claim to have proved that the latitude of points on the earth's surface varies and is constantly changing. Supposing their claim justified; and supposing furthermore that the change is progressive—what follows? The meridians of necessity must change also; and what was the true north by the meridian of one age, will not be the true north by the meridian of another age. Shall a new line be set out every time the accumulated infinitesimals become a quantity sufficiently large to measure? Whoever advocates such a course should, in order to be consistent, also advocate the readjustment of every section and half section line, not only in Ohio, but also in every state and territory of the United States in which section lines are found. Such a man would be an enemy to the peace and dignity of the state; indeed, it would hardly be extravagant to say that he would be the enemy of mankind, and should be suppressed or incarcerated until he could furnish security for future good behavior.

Within the last few weeks I have seen it stated that somebody is trying to make trouble on account of a part of the boundary line between the United States and the Dominion of Canada, westward from Lake Superior.

Moses is credited with saying a long time ago, "Cursed be he that removeth his neighbor's land-mark, and all the people shall say Amen."

I think this is not one of the "mistakes of Moses." On the contrary, Ohio goes one better than that, and consigns the culprit to the penitentiary for a term of years.

It is not well that nations, or states, or counties, or neighborhoods, or individuals, should be forever at strife for want of fixed boundaries. It is better that things of this nature long established should remain undisturbed.

The lawyer and the jurist say, "Stare decisis"—"stand by the decisions." Abolish the motto and the practice under it; where would the lawyer and the jurist be? Perhaps one had

better say, Where would the clients,—Where would you and I be, unless between the upper and the nether millstones?

"Stand by the decisions." Let long-established lines remain undisturbed, especially when it is shown that they stand where their authors intended to put them, and where they did put them. The Supreme Court of Ohio and all the inferior courts have jurisdiction, compel surveyors to find the old lines as originally run, if it can be done, and that without one word about due north, or any other such thing. And the courts are right—end even if they were not, we cannot go "behind their returns." Pursue the course here advocated, then nations, and states, and counties, and neighborhoods, and individuals may rest in peace, so far as this question is concerned; the earth may swing this way and that; the latitudes may change if they will, or the meridians reel like a drunken man;—trouble from this cause will have ceased; and so far as surveyors are concerned, the time will have come when "The wolf shall dwell with the lamb, and the leopard shall lie down with the kid; and the calf and the young lion, and the fatling together, and a little child shall lead them."

Note.—After the delivery of the preceding discourse, I took occasion to examine all the lines of the six counties referred to, and I find that in every case the boundary lines follow section lines. I find also in one of the counties, Lucas, that the expression "due west" is used twice, and in both cases it is fixed on lines already surveyed. It appears, therefore, that in the six cases in which "due east" or "due west," etc., have been used in the statutes of Ohio, five times it was fixed on lines already surveyed, as so fixed by the very words of the statute; and in the single case where it is not so fixed by language of the statute, the line was made to follow the section lines and has so remained for more than 60 years. This line is the south boundary of Columbiana county adjoining the Ohio river.

In changing county boundaries I find in every case, where there are section lines, the boundaries of counties follow these lines; so that in all there are more than four hundred cases in which the words of the statutes have fixed the county bound-

aries on the surveyed lines, and not a single case to the contrary. The east boundary of Butler and the east boundary of Montgomery can not, by any fair means, be detached from what is otherwise the invariable rule. R. W. M.

DISCUSSION.

Chairman Strawn: I am sure we have all listened with intense interest to Professor McFarland's paper, and opportunity will now be given for a discussion of the same.

Colonel Innis: What difference do you make between "west" and "westerly?"

Professor McFarland: I just quoted the statute. I suppose the Legislature knew that it might be eight or ten degrees out of the way and just said "westerly."

Colonel Innis: Haven't the courts decided that westerly means west, and northerly means north?

Professor McFarland: I don't know. I think it would be sensible, at any rate.

Mr. Snow: I would like to ask the gentleman if he ever found township lines straight from one corner to another?

Professor McFarland: No, sir; because they vary back and forth a little—a few rods sometimes, sometimes only a rod or two. I think it would be well enough for the surveyors of the state to look into the records of the counties and see how few lines are put down just a mile. Twenty years ago I went over to the state house and began the study, and I found that not one pretends to be eighty chains long. I used the original notes for Perry county and perhaps five or six others, and they would differ as much as twelve or fifteen rods, and then others can not be parallel. So I say let us give and take a little.

Chairman Strawn: I have been over a part of those lines between Columbiana and Jefferson counties and between Columbiana and Carroll counties, and I found some lines called due east that are probably two degrees and more from being due east.

Mr. Gilpatrick: What would you suggest to the surveyors of the state to prevent or remedy mistakes in marking boundaries?

Professor McFarland: That is a pretty large question to answer. There is a little book printed by the state, drawn by Mr. Bowen of this city, a most excellent book for engineers and surveyors, which will tell you more than I could in a week.

Mr. Gilpatrick: What would you suggest in the form of permanent marks for corners?

Professor McFarland: I think they should be large stones, set well into the earth and sticking up so they can be seen.

Mr. Gilpatrick: What do you mean by large?

Professor McFarland: At least a foot square. In some places where I have made surveys I have found large stones eighteen inches square in cross section, and extending upwards out of the ground two or three feet.

Occasionally you will find a man who will run away with his neighbor's landmark. One time I was fixing a corner not far from Oxford, in Butler county. Some man said: "It is no use to put a corner-stone there, for the man always pulls it up." I thought I would fix it so he could not pull it up. The old witness trees were still there, but he had put the corner perhaps two rods on the other man's land. They had all four signed a paper to stand by the corner I should make. There were the two witness trees, so I could not miss it two inches. I got the boys to help, and we rolled up a boulder almost as large as the big boulder at the State University. We rolled it up by main strength and planted it there, leaving a portion not larger than a man's head out of the ground. Some six months after that I was passing the same line, and when I passed the old corner found six or seven rails had been driven, perhaps a foot or two in the ground; but the stone was still there and the rails too.

Chairman Strawn: The answer to Mr. Gilpatrick's question as to character of monuments, depends much on where you are surveying. I happened once to be surveying in Michigan, where there was not a stone in several miles. What would you do there? I suppose you would do just as the surveyors there do—take possibly a good pine stick, drive it to considerable depth in the ground and heap up a mound of earth above it. I found

a number of government surveys not long after that had been made which were marked in that way. There are no stones to mark with. I have found in some parts of this state they are making terra cotta markers, say two and a half feet long, and using them in place of stone, where stone is difficult to get. In another place where neither stone nor terra cotta could be gotten, but where iron was easily obtainable, they cut iron bars four, five or six feet long and drove those bars into the earth. Those bars would weigh quite a number of pounds. We must take things as we find them under different conditions.

Mr. Gilpatrick: I am so deeply impressed with the importance of properly and permanently marking county and town corners that it seems worth while to make an effort to impress the commissioners with the necessity of providing suitable monuments, both so far as material and size is concerned. They should be of uniform size, and should be used in the marking of every line or corner. I believe it would be dollars and cents in the pockets of the landowners of the townships and counties; it would save litigation and neighborhood quarrels which are injurious in every sense to the well-being of society and the peace of communities.

Mr. Snow: I have used a good many different kinds of corners. The gentleman speaks of stone; in some parts of our county we have many, in other parts none. Where there are so many it is difficult to identify the stone put at the corner. I have used in those cases brick, or in some cases sewer tile—2-inch tile. In some cases I have thrown in a lot of old glass or pieces of brick, that the corner might be identified. As to uniformity of monuments, it seems to me if we would use something that is manufactured, as terra cotta monument, or sewer tile, or brick, then we could always identify it because there would be nothing else there like it.

Mr. McKay: I think this monument question is one which we might discuss with profit. I have used in my work two stones, marking both stones. I put one stone down fifteen inches under ground and marked it with a chisel. Then I put another on top of that and marked it also, and made a description of it

in my notes. Then if one stone is removed we can dig down and find the other. Often I do not put in the extra stone; I have thrown in broken glass or boulders, stating the number in my notes and setting the regular monument on top of that. It is important that the record be made so the corner can be recognized. I don't think it matters what is put in, so the record is made so carefully that it may be recognized without mistake.

THE TORRENS LAW.

HOSEA PAUL, CLEVELAND.

In offering for your consideration some remarks upon the Torrens system of registering titles, now legalized in this state but not actually put in practice, I may say that, in my opinion, one can not well discuss this interesting, timely and important subject without in a very considerable degree bringing up the more general one of deeds and records. If our present systems are suitable and sufficient, surely no disturbing innovations should be thought of. If, however, there are short-comings and deficiencies, it will be in order to talk of reforms if not of revolutions; whether we shall patch up, revamp and remodel what we have, or build anew from the ground up. I believe that no profession is better qualified to deal with these questions than our own. Of all men, the surveyor is the maker, interpreter and the user of deeds. The county surveyor in Ohio has the same power to take acknowledgements as a notary or justice, and many other surveyors hold a notary's commission for the purpose of acting as a scrivener or conveyancer. The manner, therefore, in which deeds are made is of vital and every-day interest to the surveyor. But a deed is not like some other legal papers—a mere memorandum of a bargain, transaction or settlement between two individuals, or one of temporary interest. It is essentially a public paper and possesses a lasting interest. Then, again, we cannot often use the deeds

themselves, but depend for our knowledge of them on the copies made by public authority. These copies multiply in number and in time the problem is presented, how shall this mass of information be arranged and made available for the constant and seemingly never-ending task of referring to it? To properly locate a single corner it is frequently necessary for the surveyor to examine a dozen deeds for the reason that any particular description is likely to refer to or depend upon one of former date, or of adjoining land, and then, too, as one description is copied from another it seems to be the cheerful habit of some conveyancers to introduce novelties and variations, and sometimes after being copied three or four times the original description is so changed that it can scarcely be recognized, and the provoking thing is that the changes made are not always improvements. Perhaps the most common of these changes is the attempt to qualify, change or break the force of statements. With some men everything comes out of their hands as "abouts;" with others possibly no more accurate, all statements will be absolute. But I am not undertaking to discuss descriptions, but rather how we are going to find the dozen or hundred of them that may be needed to establish a corner, to prepare a street frontage, or sewer district, or drainage area map, or to make a right of way map for a railroad.

I must omit, I fear, any discussions of the forms of deeds, though I will say that in my opinion they ought to be shortened. This is especially the case in regard to mortgages. They purport to be both an absolute and a conditional conveyance. They cannot well be both, and are in fact neither one or the other. They should simply consist of a grant or creation of a lien, and this lien should absolutely terminate at a fixed date of, say, fifteen years.

This matter of record-searching is assuming very serious and rapidly-growing proportions to the surveyor. We dislike the poring over the lists of names that pass for indexes in the dim light of damp and stuffy vaults, the must and dust, the lifting of heavy volumes, and the cramped positions in copying that are almost certain features of this sort of work. But worse than

physical discomforts or the frequent sense of possible incompleteness, that the search ought to have been extended, is that the most patient and thorough work is rarely appreciated or fully paid for.

I fancy that some may ask, Why not leave this work of record-searching to the professional abstract makers? They are generally supposed to be better prepared to do the work, and certainly have better luck in making it financially profitable. The answer seems to be that their qualifications and facilities for this work are sometimes over-rated. The average abstract is very apt to contain a great deal of information that is of no particular interest to the surveyor, and to omit the very thing that he is looking for. This is especially the case when, as is the custom, the abstract gives only what is retained of an original tract, and we can only tell definitely what has been retained when we know what has been sold out, and this information is only to be found in that unusual kind of abstracts that takes in all the surrounding property, and this is sure to be so bulky that the task of picking out the required information is little, if any less, than finding it originally in the records and involves an expense which is generally prohibitory.

The remedy for all this would be to have the records so conveniently arranged and so thoroughly indexed that a person could look them over and pick out just what he wanted in the minimum of time. As it is now the system is crude, cumberous and rapidly becoming intolerable. If this were not a patent fact, there never would have been any serious attempt to introduce the Torrens system in Ohio. Now I am not undertaking at this time to be the champion of this particular law, but I do say that they who fight it simply because they do not realize that we have out-grown our present system are making a mistake. There must be changes, modifications and improvements in matters relating to conveyancing as well as in other things. This being granted, we can then intelligently consider whether we can best get what we want by improving our old system or introducing an entirely new one. There is one thing I wish to call your attention to later, and that is whether adopt the Torrens

system or not, there will be almost of necessity a rearrangement of what we already have accumulated.

The new system proposes to find out exactly as may be, what every man owns, and the kind and nature of all liens and incumberances upon it, and to make this out in the form of a certificate, a copy of which is to be given to him, and if he sells it to cancel the old certificate and issue a new one to the new owner, the deed or the document taking the place of the deed; being more properly an order on the registering officer to transfer the title to the new owner and being further unlike a deed in not in itself being a subject of record, but merely filed. The registered title then consists merely of a statement or certificate that John Alexander Brown owns the following lands, and that it is subject to the following liens and incumbrances, of which a brief memorandum or "memorial," as it is called, is made, the instrument creating them being indicated by such memorial, but not set out in full, and in case the title is transferred to a new owner, a new certificate or statement is made out on another page for the new owner. It is then a complete, connected, up-to-date abstract, and in the Ohio law provision is made for the entering up of liens from other offices besides those actually found in the recorder's office. It might further be called a ledger account as compared with the scattered items of a day book.

Now all this involves considerable expense, especially at the outset. There must be, of necessity, a complete abstract made, and then a judicial interpretation of the title by a court under the forms of a suit of law, with notice to all the parties in interest as shown by the abstract or found out by publication or otherwise. In those cases where the descriptions are indefinite or conflicting, surveys may be ordered, and testimony taken. The theory of the law seems to be first to find out exactly what the title is once for all, and not to open up the question again, and when settled in this way, the state then becomes a warranter or insurer of the validity and correctness, the skill, thoroughness and honesty of its officers, and in case of actual mistake or error to make payment to the party suffering loss, a fund being provided for such payments, by a small tax of the nature of an

insurance premium levied and collected in proportion to its value on all registered property.

Perhaps the most important feature of the law that affects surveys, will flow from the provision that abolishes the old established rule by which it is now possible to hold land by long continued and adverse possession. How completely this will change the work of the surveyor, may be easily imagined. I do not say, however, that it will always be possible to locate the registered line from the description alone. That will depend on the accuracy of both the old and the new surveys, and how closely one may be made to fit the other. I imagine, too, that cases will still arise, as they do now, when the presumption may be safely ventured that the fence, building or other fact of occupation may be accepted as being on the proper and original line, even though a literal following of the descriptions may seem to put it elsewhere. But as to what is plainly an encroachment, the surveyor need no longer be troubled by the statute of limitations.

Now as to the practical use of registered titles. Until they are all registered, and I doubt not occasionally thereafter, the surveyor will still have occasion to search the old records. No law, however absolute in its terms, or however carefully constructed, can altogether obviate this necessity, but with complete abstracts on file, this work will be greatly simplified.

Perhaps, however, the main objection to registering titles is because of the expense involved. First, an abstract and, possibly, surveys; second, a judicial determination of the title. Of these, ordinarily, the abstract will be the principal item of expense. But in these days, abstracts have become pretty nearly indispensible things, and are often made over and over again for the same land. They are, moreover, private papers, not readily accessible, if known to exist. But, for the purposes of registration, the abstract once made, it would serve for all time, and be always accessible in a public office.

But the cost of making abstracts for this or any other purpose ought to be, and could be, easily and greatly reduced. I am somewhat acquainted with the records of many counties of this

and other states, and I may say that, in my judgment, the best of them are very imperfect and antiquated.

The first trouble is that, in recording the deeds, there is no intelligent order. They write them in big books, as they are presented, and in almost any county there are from one to five hundred volumes, bulky, dusty and put away in dark corners. To find the deeds relating to any particular township or locality, one may have to handle every book in the office. The right way would be to record the deeds for each particular township, or part of a township, in a book by itself. In Cuyahoga county, for instance, there are townships in which every deed relating to it, if put together, would fill half a dozen volumes. As it is now, they may be scattered through upwards of some hundred books. In many counties of this state, the deeds relating to a particular township or village might, I think, be put in a single volume, and most other townships, villages or cities, are readily divisible into fractional parts that will not require more than a single volume.

If, when deeds were brought in, they were assigned to books, each of which was devoted to a particular locality, the problem of finding them would, in a great part, be solved, and a comparatively simple scheme of indexing would render them vastly more accessible than the most elaborate scheme of any abstract firm in the county. As to indeces, I believe in them somewhat as I believe in drugs, prisons and wars. They are mainly necessary because of diseased conditions, imperfect organism, error, fault and crime. We rely upon our index to cure defects of original arrangement, to find that which never need to have been lost or misplaced, and which we might, if we cared to, put our hand on as easily as upon the index itself.

But as to the old volumes, and until a new practice is obtained, we must depend on indeces, as before. But then, there is no reason why we should not have good ones, and in this connection, let me state an axiom that ought to be accepted and insisted upon—the finding of a deed ought to be as simple as the finding of a name in a city directory. The best way to do this would no doubt be by the card system, such as is used in libraries. In a

good library, a book can be produced in a very few moments, and certainly, there is no reason why it should take any longer to find a deed.

There are some very strong objections made to the whole system of registration. I do not intend to consider the objections of those who see no reason why the present system should be changed at all, and who believe it represents human wisdom in high development. But people have a right to discuss the Torrens system or any other new system on its merits, and the principal objections raised against it are from its assumed undesirability and from its expense, which is admitted to be considerable.

It is asserted by some, to be wrong that the state should undertake to determine these things, but leave it to private individuals to find out such matters in their own way, as they have occasion. It is also pointed out that the judicial hearings are in danger of being ex parte to the extent that the slumbering interests of inattentive or unknown parties may be neglected or overlooked. The insurance provision is also the subject of criticism. There is certainly force and reason in these and similar objections. I can see where there may be some injustice possible, and I can also see that there is injustice possible under the present system, but whether all this will out weight the many and manifest advantages of the law, I will not now consider.

In this connection, let me say something about records of plats, subdivisions. In Cuyahoga county, there are already some twenty-five large volumes, each containing from 30 to 50 pages, 26x28 inches.

In regard to these records, I may say first, that it is a much more difficult thing to make an accurate and complete copy of a map or plat than of a written or printed instrument. Lines and figures are sometimes omitted, and, in some cases, wrong ones are put in. As to this, I recall an instance at Alliance. A part of the town plat was surveyed and a plat of it made by the surveyor, which was put upon record. The surveyor, about the same time made another map to show the same subdivision. The county recorder also made a certified copy of the record.

Here we have three official plats and another practically so, four plats in all, and the fact is, no two of them are alike, but they all differ in several important particulars.

I recall another case at Cleveland, in my own experience, a few months ago. I made a copy of an allotment for the purpose of making a survey, and, upon going to the ground, I noticed that at one corner of the allotment there were three stakes and one stone, differing something over a foot. I wondered why the stone was there and why it had not been accepted, especially as its appearance was similar to other stones in the same vicinity. I again examined the record and verified my copy; there was no mention of a stone at this point. It then occurred to me that, though the original owner who laid out the sublots had sold them many years ago and was now dead, it was very probable that I might find his papers. I accordingly inquired at his old office and the original plat was quickly laid before me and, sure enough, the word "stone" was plainly written at that corner and, although, as is the custom, the plat had been used to make all sorts of memoranda respecting purchasers' names, dates and prices, it was easy to pick out the surveyor's lines and figures, and to see that the recorder, although a careful man, who knew the value of such things, had, nevertheless, made a very important omission.

On another occasion, also in Cleveland, in making a survey of a lot at the extreme south end of a long subdivision, I found that, in the recorded plat, the frontage of the last lot had been omitted. Under the circumstances, it seemed to be my duty to mark off the lengths of the lots from the north, leaving the remainder to the last, without any allowance for surplus or difference of measure. Several years later, I had occasion to make another survey in the same immediate locality, and, upon again examining the record, I found, that, since I had last used it, a red ink notation had been added by the recorder to the effect that the original map had been produced, and the missing frontage added to the record. By using these frontages, as I now felt obliged to, there was a surplus and, therefore, a different location of the corners.

Another thing about these records, they are handled a great deal. One book is placed upon the open page of another, and the lines and figures, no matter how carefully made, are soon rubbed out, and then there is a call for a new copy. In Cuyahoga county some of the maps have been copied a third time, and a fourth one seems likely at an early date. I should judge that they did not last over fifteen or twenty years. I might say, that if the plats were arranged geographically, the amount of such wear would be greatly reduced. But the real way to meet the difficulty is to follow the precedent of the Patent Office, and require the original map to be photo-lithographed. In this way, an absolutely fac-simile copy is obtained, about which there can be no possible question, and, more than this, a considerable number of sheets can be printed and sold to whoever wants them. As it is now, every surveyor and abstractor is taking, and, to some extent, preserving more or less complete copies of the plats, sometimes mere sketches; but, as they are generally made for a particular occasion and purpose, are of very little use under other circumstances. All this imperfect sketching would be avoided and the complete plats could be sold at such low prices that nobody could afford to spend time making their own copies. As for these photographic fac-similes, the surveyor would be responsible for appearance and accuracy, and he could not say, as now, in case of discovered error, "That must have been a mistake in recording." It must be remembered, however, that no matter how carefully and elegantly deeds and maps are drawn originally, such originals are of very little use. The record is the real thing the public makes use of and depends upon, and printed fac-similes would definitely and quickly increase our confidence and be a distinct gain in every way.

Every surveyor in active practice would, as a rule, buy these plats as fast as they were printed. If, however, it is a good thing to print plats, why not print the deeds also? This done, there will be so many advantages in legibility, saving of bulk, the possibility of combinations, alphabetical, consecutive and geographical in so many other ways, that the whole problem of

indexing, copying, searching and abstracting would be solved on new lines.

These advantages are so great, so many and so obvious, that I will not undertake to enumerate them, and will conclude by suggesting to some of these excellent gentlemen who are so bitterly opposed to the Torrens system, to take up this subject along this or some other line, which recognizes the necessity and possibility of improvement, and it may be that the growing needs of the day may be met by some other method. But it will be as idle to deny that no change is needed, as it would be to assert that the world is flat, or the sun moves.

DISCUSSION.

Chairman Strawn: We will have a few minutes for the discussion of the subject treated of in this paper. Let those who desire to talk on the subject, speak promptly and pointedly.

Mr. Cronley: The suggestion contained in the paper accords in part with the provisions carried out by our county. Some years ago an abstracting company went to work and made complete abstracts of all the land in the county, and the county comissioners paid the company four thousand dollars for all these abstracts. Now, it is only necessary to know the township and range in which land is situated to be able to tell by the books in the recorder's office whether a deed or mortgage has been recorded; and these same books correspond with the county auditor's book. It is not necessary to employ a lawyer; any person of ordinary intelligence can go and look up the abstract.

REPORT OF COMMITTEE ON LAND SURVEYING AND DRAINAGE.

HOMER C. WHITE, CHAIRMAN.

Mr. President:

Your Committee on Land Surveying and Drainage begs to report as follows:

So broad is the scope of either branch of our subject, that with the two combined, we stand appalled. We hesitate where to begin, we dare not anticipate where or how we shall end. With only a very moderate assistance from a minority of the members of the committee, the chairman found, when the time for work was short, that the burden of the preparation of the report had fallen upon him; he will, therefore, take this opportunity to state that the committee "as a body, is not responsible for the statements and opinions advanced in this report."

Samuel Craig, and D. W. Seitz are exceptions to the above rule. Brother Craig reports a novel piece of work upon which he is now engaged, to wit: A ditch twenty-one hundred and fifty feet long, the gradient of which is a dead level. He wants to know if any other member has experimented in this way? He says: "Seventeen years ago I established one mile of level grade on a prairie ditch which gave and is still giving satisfaction."

For myself, I have never experimented along this line; one-half inch to the hundred feet is the flattest gradient that I have ever been obliged to use; but, I don't see why Brother Craig's scheme will not work if the ditch is only deep enough. We had a surveyor in our county once who, if I may be allowed to use a homely expression, could "see" Brother Craig's level ditch and "go him one better,"—the outlet of his ditch was higher than the head, and as a drainage scheme (not from a hydraulic, but from a moral and financial standpoint) it was a howling success; it drained the whole neighborhood thoroughly and effectually, and when remonstrated with by interested property owners, I am told, but won't vouch for it as true, that the surveyor should

have said that it was a common thing for water to run up hill, and cited the Mississippi river as a parallel case.

Brother Seitz suggests urging the necessity of encouraging a higher standard in the practice of land surveying. He says: "The proposed Ohio land surveys should be pushed to the front, and I hope the Society will be able to get our legislators interested so as to secure the passage of some bill that will secure to the land owners of the state the best talent for the protection of their rights. I believe the bill proposed at the last meeting, '96, to be in the main, a good one." To all of which the other members of the committee, through its chairman, say: "Amen." And then Brother Seitz goes on to say, that owing to pressure of business and shortness of time he fears that he will not be able to meet with us. Now, I just feel like switching off from the subject before us long enough to censure Brother Seitz for his inconsistency. If he is truly and sincerely in earnest in his desire to encourage a higher standard of surveying, he should be present at this meeting; that is the sole aim and object of the perpetuation of this and kindred societies.

LAND SURVEYING.

The relocation of the boundary line between the United States and Mexico is briefly outlined in a paper read before the Engineering Association of the South, by Bernard A. Wood, and published in the Annual of that association for the year 1896. For the benefit of such of our members as have been too busy to read the exchanges, we will briefly review the article.

That part of the boundary line relocated begins at the point of intersection of parallel 31° 47′ north with the center of the Rio Grande; thence west along said parallel 100 miles; thence south to the intersection of parallel 31° 20′ north; thence west along said parallel to the 111th meridian; thence to a point in the center of the Colorado river, 20 miles below its junction with the Gila; thence northwardly with the center of the Colorado river to the said junction; thence westwardly to a point on the Pacific ocean one marine league south of the south end of San Diego bay.

This line was originally located in the year 1853. In 1888 the United States and Mexico entered into a treaty by which the line was to be re-surveyed and permanently marked. The commissioners on the part of the United States were Lieutenant Colonel J. W. Barlow and First Lieutenant D. D. Galliard, of the corps of engineers, and Mr. A. T. Mosman, of the coast and geodetic survey. For the proper prosecution of the work the force was organized into four parties, namely: Astronomical, tangent, topographical and monument, each working under the direction of an engineer in charge. For further particulars you are referred to Mr. Wood's paper.

The Venezuela boundary dispute is now famous the world over, not for the high grade of engineering skill exercised by learned and accomplished knights of the solar transit and nautical almanac, in determining precisely the exact location of the line in dispute, but famous for the results which have indirectly grown out of the efforts of the representatives of the greatest republic and the greatest empire on the face of the earth to have matters of dispute between nations settled by arbitration rather than by war. I refer to the treaty recently signed at Washington by Secretary of State Olney on behalf of the United States and Sir Julian Pauncefote on behalf of Great Britain, by which, for a term of five years, the two nations agree to abide in peace, referring all questions of controversy to a court of arbitration. The treaty is yet to be ratified by the law-making bodies of the two nations. We await the result with interest; the whole world is interested, and if success crowns the effort, who will dare say that international bimetallism is not a possibility of the future?

The world moves. It is getting better and more civilized every day, Turkey and Spain's spasmodic efforts at self-preservation to the contrary notwithstanding. We expect to see the day when two farmers, instead of lawing away their farms over a few feet of worthless ground, or jumping into each other with bowie-knives and pistols, will take a common-sense view of the matter and settle their disputes by the much less expensive, and in the end, far more satisfactory method of arbitration.

DRAINAGE.

The Chicago drainage canal is probably the most expensive piece of drainage work undertaken in recent years. The estimated cost of work under contract is $21,849,055.59, of which $2,606,227.92 is for right of way. There had been expended May 1st, 1896, $16,026,717.15, and this amount, together with the cost of administration, payment of bonds, interest, etc., brings the total expenditures for the district to May 1, 1896, to about $21,936,000. The total amount of excavation involved in the construction of the main channel, in addition to about thirteen miles of river improvements, is 28,067,889 cubic yards of glacial drift, and 12,265,653 cubic yards of solid rock, total 40,333,542 cubic yards. Up to May 1, 1896, glacial drift to the amount of 21,654,064 cubic yards, and 11,112,191 cubic yards of solid rock had been excavated, a total of 32,766,255 cubic yards. The average daily output of rock for the month of June, 1895, reached 21,365 cubic yards, requiring the use of eight tons of dynamite. Cross-section of main channel in rock is 160 feet wide at bottom and 162 feet at top, grade one foot in 20,000 feet, or .05 per 1,000 feet. Almost as flat as Brother Craig's ditch. Cable ways, high-power derricks and cantilever conveyors are employed upon the work, and steam, electric, hydraulic and pneumatic systems are each employed to convey power to various parts of the work.

We are indebted for the above information to the Railroad Gazette for August 28, 1896.

Land drainage, either by open ditches or by means of field tile, on a scale suitable to the means of owners of small tracts of land, should properly be noticed in this report, but I have allowed descriptions of the larger undertakings to occupy so much space and have not had time to attend to the boiling-down process, that I shall have to content myself with citations to a few articles on the subject only, namely: "Farm Drainage," by John Corvine, in Clay Record; also, same issue, "Drainage Laws," by Joseph A. Williams. Upon the subject of irrigation, which may be styled as a minus quantity under the head of drainage, an article appears in the Engineering News for September

17, 1896, on the Pecos Valley Irrigation System, giving a very interesting account of the methods employed for storing water for the irrigation of 200,000 acres of land.

Following are a few Supreme Court decisions appearing in the 53d Ohio State Report, touching drainage and boundary lines, which may be of interest.

Railroad Company vs. Platt et al. (53 Ohio State Report, page 254).

A conveyance of land situated upon a navigable stream, the description being by courses and distances from a fixed monument and establishing a boundary line coincident with the line of navigation, conveys the grantor's title as far as the central thread of the stream.

Railway Company et al. vs. Williams:

An owner of land who sells to a railroad company a right of way for its road by a written contract in which the description of the land is indefinite, and after the road is constructed, accepted, with full knowledge of the facts and without objection the compensation agreed to be paid, and acquiesces for a period of six years in the occupancy by the company of the right of way on which the road is so constructed, is estopped to deny that such location is the location originally agreed upon and to demand additional compensation. (53 Ohio State Report, page 268.)

City of Toledo vs. Sheill et al.:

1. Where the boundary lines of a corner lot extend along one side of its two abutting streets a materially greater distance than along the other, a presumption arises that it fronts upon the latter street.

2. Where the shape and dimensions of a corner lot raise a presumption that it fronts on a particular street while vacant, such presumption continues after it has been improved, unless rebutted by the style and character of the improvements.

3. Where a single business house is erected on a corner lot, the front of which, according to its plan of construction, or style of architecture accords with the presumed front of the lot, while the latter was vacant, such front is not changed, although the

building is provided with doors and halls that permit an extensive use of the other, or lengthwise, street, and afterwards such use is freely made by the occupants of the building.

4. Where a dwelling house is erected on a corner lot, the front of which, according to its plan of construction, or style of architecture corresponds with that of the lot, when the latter was vacant, the original front is not changed, although the building is provided with entrances opening on the lengthwise street, that are extensively used by its occupants and appurtenant structures erected that are accessible only from the latter street. Such use of the side street is incidental only to the occupation of the dwelling house.

5. Where both a dwelling house and a business house are erected separately on a corner lot, the former fronting on the breadthwise street, and the latter on the lengthwise street, so much of the lot as the latter building occupies, or is clearly used as appurtenant to it, should be held to front on the street which it faces. (53 Ohio State Report, page —.)

City of Zanesville vs. Fannan:

Municipality liable for damages caused by obstruction to drainage by reason of the construction of railroad tracks upon the streets of the city,the railroad company having obtained permission from the municipality to do so. (53 O. S. R., p. 605.)

Commissioners of Putnam County et al. vs. Kraus et al. (53 O. S. R., p. 628.):

Where under the ditch laws of the state, a ditch has been ordered and established by the county commissioners, and the construction paid for from the county treasury, on certificates of the engineer appointed to superintend the work, the assessment made to reimburse the county for the payments made from its treasury, cannot be enjoined by the landowners on the ground simply that the ditch was not constructed according to the contract and specifications, and does not drain their lands. An action upon the bond of the engineer, or of the contractors, or of both, is the proper remedy in such cases; and if not adequate, it is from the fault of the land owners in not having made their objections to the engineer or in not having caused his removal for dereliction of duty.

RELOCATING THE LOST CORNER OF FOUR TOWNSHIPS AND OTHER LOST CORNERS.

G. S. INNIS, COLUMBUS.

I have learned from others, as well as my own experience, to regard the following rules as axioms as seldom, if ever, to be departed from in making a survey for the purpose of finding old lines or corners:

1. A resurvey, made after the monuments of the original survey have disappeared, is for the purpose of determining where these monuments were, and not where they should have been.

2. Never depart from, or move old stones or other monuments, especially where they have been accepted as correct by all parties in interest.

3. Stones, iron stakes, or other objects, not called for in deeds or descriptions, are not monuments and are of no value in a survey, unless found to be correct.

4. Stones, posts, stakes or other objects set at the time a survey was made, must control, however erroneous.

5. Never undertake to correct an error, made in an original survey, but follow the survey if it can be done. The original survey must govern.

6. Surplus or shortage in a block must be divided pro rata, between the lots or parcels of land, when the monuments or original stakes are gone.

7. A long established fence (more than twenty-one years) is better evidence of location, where possession has been constant, with the present owner and those under whom he claims than any recent survey made, after the monuments have disappeared.

8. There is great virtue in a pick and shovel intelligently applied in finding lost corners, where stakes have been driven, or stones planted and removed.

9. Never be controlled, by the opinion of land owners, unless they can show monuments or other evidence of the true corner. A compass and chain intelligently and skillfully used,

with the assistance of a pick and shovel, will generally give good results.

10. Never go to the field to make a survey or repeat an old one without complete notes of the land to be surveyed, and a plat of it with bearings and distances on the several lines. This plat should include the surrounding lands, unless there are undisputed monuments at each corner of the land to be surveyed.

11. It is very important for a surveyor to have a critical knowledge of all kinds of timber growing in the country where he has work to do. Any one having experience of clearing up several farms, making his own rails, building his own fences and seeing them rot down, etc., could hardly fail of acquiring this useful knowledge.

An assistant was riding in the same wagon with me, and passing a hard maple or sugar tree which was very pretty, he pointed to it, saying: "There is the nicest oak tree I ever saw." After getting to our work he was handling the transit and was good at that. He ran out to a corner where a red oak tree was called for in the notes, yet he went farther away, and commenced digging around a white oak tree for his corner. Being corrected, he concluded he would learn the different kinds of timber. Passing a large tall beech tree, he struck it a lick, and asked: "What kind of an oak do you call that?" Well, that was the way to learn.

12. Then a surveyor, unless he wants to be a laughing stock, must well understand English Grammar, from the first rudiments to its completion, so he may be able to use good language and especially spell correctly in making up his reports. In nearly every case the surveyor must write reports for boards of commissioners in partition and similar cases. It should be well done, clear, and beyond question plain.

13. There is no principle of more importance to the surveyor or civil engineer than strict integrity. He, being frequently called upon to decide disputed points between others, must not be influenced in his work by any other consideration than exact justice between the parties. Any other course is professional suicide.

EXPERIENCE IN THE FIELD.

The people owning land, and living near where the corners of Clinton, Sharon, Blendon and Mifflin townships coincide, had been in controversy about where this corner was originally located. There had been several law suits tried in the Common Pleas court. In each case a board of commissioners, with a surveyor, had been appointed, did the work ordered as best they could, and made the required return.

Still, some of the land owners were dissatisfied and appealed to what is now the Circuit court.

This court appointed Walter Field, Virgil D. Moore and G. S. Innis as commissioners, and W. W. Pollard surveyor, to find where said corner was originally located. They worked about a week, beginning at the northeast corner of Mifflin township, where an old corner-stone was found, and running west along the south line of Blendon and Sharon, and north line of Mifflin and Clinton to a corner-stone in the northwest corner of Clinton, and southwest corner of Sharon, passing a number of stones, some in line, but more out of line. This line seemed to agree with the former work, and was satisfactory to Messrs. Field and Pollard. The other two commissioners were not convinced of its correctness for the reason that they doubted this ten-mile line being originally straight, as it was run with a compass and through the woods. For a like reason, they were not sure the present line had been made a right line, for ten miles, with only a surveyor's compass with which to do the work. They insisted that some evidence of the old corner be found nearer to it. Things looked as though the commissioners would disagree, and make two reports. After consulting Moore, Innis said to the others, "Give me the surveying tools for one day, and all of you turn in and help. If at the end of that time I cannot convince you that you are wrong I will agree with you." The tools being handed over, I went to the southeast corner of the northeast lot of Clinton township, and having the full notes of the original survey of that quarter, and Mr. Kilbourne's full notes of the resurvey of it, made about twenty-five years before, found that a white elm tree, 12 inches in diameter, was called for as a witness

tree. No such tree was there, but there was a white elm thirty inches in diameter. A man was given an ax and requested to cut in and block out the wood until he found the old marks. He soon tired, as white elm of rapid growth is hard to split. I said to him: "You are lazy," taking the ax and giving it to another. He was found a better axman, and soon had the blocks out sufficiently to show the old witness marks, both notch and blaze, as plainly as though just made. Taking course and distance to the corner, it was found to have been in a low wet place, although then dry. A spade was used to throw earth out of a space some three feet in diameter, taking out about one inch at a time.

When the hole was some twelve inches deep, the spade struck a hard substance, which proved to be the sharpened end of an old stake, made from the butt end of a small white oak tree. The place was tested and found at the bearing and distance given in the notes. This was good enough so far. The next thing to do was to measure the given distance along the east line of Clinton township, to the northeast corner of Lot No. 12, being the northwest corner of Mifflin and southeast corner of Sharon townships, the corner sought to be located.

When the party had measured the distance given in the notes by Mr. Kilbourne the men found it must have been located in rather a deep pond, which had been filled some three feet, to make the proper grade for the Columbus and Lockwin plank road.

The plank was taken off and a large hole dug down through this fill to the natural earth. Here water was found, although it was a very dry time. This was quite encouraging, as the water would naturally prevent a wooden stake from decaying. It was with some difficulty the bottom of this hole was carefully scraped, but the effort was finally successful. The stake was found and proved to be a match for the former one taken out of the ground.

Then the party started for the northwest corner of a forty-acre parcel of land in said Lot No. 12, measuring the distance very carefully. This being done, a stake was driven deep enough to keep the place. The southwest corner of said lot was sought. I, when a boy some ten or twelve years old, being with the survey-

ing party, saw stones planted in these western corners to Dr. Wm. A. Morse's forty acres of land. I also had seen the doctor put broken crockery and glassware under and about these stones, and later saw him set a black locust tree against the southwest corner stone. This tree was still there, but had grown to be some twenty inches in diameter, and no stone to be seen. On looking around the tree I saw some difference in the bark on the side of it. Taking an ax I struck the tree in this place with its poll, and heard a hollow sound. The wood being removed, the corner stone was found, and the measurement taken to the northwest corner of the doctor's land. On this north line had been laid out and opened a county road. Here another hole being dug in the center of this road, another stone was found, with broken crockery and glassware under it. This was enough, all agreeing that the point where the stake was found under the plank road was the true corner. In this place a good stone was set and marked. The commissioners reported accordingly. The report was confirmed by the court without opposition. Lawsuits were withdrawn. The land owners were satisfied and have so remained.

RUNNING A DISPUTED LINE AND FINDING A COVERED CORNER.

A few years ago the land owners of the vicinity petitioned for a free turnpike along the north line of Surveys 3,356 and 422, Virginia Military District. This line had been accurately run from an old corner stone in the northwest angle of said survey, No. 3,356, to the southeast corner of Lot No. 33, of Michael L. Sullivant's subdivision, of farming lands near Columbus, Ohio. The proper steps had been taken to locate and establish the turnpike and the contract let for the building the same. While this business was being transacted a man was employed to run the same line. He was all right at the stone in the said northwest angle, but at the east end he was about 35 feet too far north. This made quite a controversy along the line. The contractor was enjoined from proceeding with his work and everything brought to a standstill. I was requested to run this line. Having

full notes of it, taken for a former survey of the lands south of the line in question, I began at the same old stone in the northwest angle of said survey No. 3,356 and ran north 68 degrees east, about two-thirds of the distance to the eastern terminus of said turnpike. Here a black walnut tree, 20 inches in diameter was called for in the old notes of the survey, and a little farther on two white oaks in the northwest corner of said survey No. 422. There was a county road along this line and everything looked smooth. Still at it the men went with pick and shovel to find the roots of this walnut tree.

After about two hours' work a root was struck. This being uncovered and examined, proved to be, unquestionably, black walnut. The remaining roots of this tree were soon uncovered, showing plainly where the tree had stood. The line was straightened up from the stone to this tree. Then produced to the two white oaks, also agreeing with them, the line was produced to the southeast corner of said lot No. 33, and did not materially differ from the former survey. Here a ring was made about five feet in diameter. A stout man was given the pick and shovel and directed to dig down to water, unless, before he found a stone. This place was in an angle of the Columbus and Harrisburg turnpike and at the junction of the Cemetery and Central avenue with said turnpike, and had evidently been filled in to the depth of four feet or more. When this well was sunk about four feet the old corner stone was found, of the same kind used by Mr. John Graham in his original subdivision of the M. L. Sullivant lands. This settled matters so thoroughly that no one disputed this being the true corner, and the turnpike was ordered by the court to be constructed on that line.

RESTORING A REMOVED CORNER STONE.

When the T. & O. C. R. R. was being built along the north line of Section No. 3, Congress lands, and along the south line of half sections Nos. 40 and 41, Refugee lands, all in Range 22, some of the land owners in the east half of Section No. 3 were of the opinion that the railroad company was over the line, and on their lands. Now some fifteen years before there had been

trouble about the line running north and south between the east and west half of said Section No. 3.

This ended in a long lawsuit and fixing a permanent corner stone in the north end of said line.

I was, soon thereafter, called upon to run over the different lots or parcels of land in the east half of said section, and found a corner stone in the northeast corner of said section, set there also by authority of the court. Being thus equipped I ran off the several parcels of land between these two stones, setting and marking stones at the north corners of said parcels of land, some five or six in number.

When testing the correctness of the south line of the railroad company's land, I found these stones all in their places and still in a straight line, except the two farthest east, which had been removed.

One, the northeast corner stone of the section. This I wished to restore from the gutter, where it was found, to its rightful place in the corner. The line, marked by the several stones in their places, was extended east to the east line of the section. This was on a high place, where the ground was composed mostly of hard clay. The pick and shovel was now used very carefully, to find the place where a hole had been dug, in this clay, large enough to hold a corner stone. A difference in the formation of the ground was soon discovered. A county road had been established, along the east line of said section and somewhat improved. In the place where the men were at work the ground was mixed with gravel and top soil and was not as solid as the natural clay.

This was all taken out and the shape of the old hole showed itself completely. This place being tested, it was found exactly in line with the stones west of it, and also in line with the east line of the section. It did not require much knowledge of the surveyor's art to conclude that this place was where the stone in the gutter had been placed. The old stone was put in its proper place, showing the roadway had been graded down by the supervisor, and this stone being in his way, he, not knowing its value, dug it up and threw it in the gutter, thereby causing all

the trouble. The railway company settled with the owners for their land occupied and all parties are satisfied.

FINDING A LOST AND DISPUTED CORNER.

Judge Gustavus Swan, owning some five acres of land on North High street, extending from Swan street on the north to the railroad lands on the south and extending east for quantity, made arrangements to the effect that this lot was to be divided into two lots of equal areas by a line running at right angles with High street. The whole area was mostly covered over either with offices, large buildings or piles of lumber. I was requested to make the survey and divide the land into two lots of equal areas.

There was no difficulty in surveying along High and Swan streets. These lines were carefully measured and found to agree with the old notes. Then the angle made by High and Swan streets was measured and found to be a right angle, as called for in the notes. No further measurements could be made on account of obstructions along the lines. The ones already taken, holding out exactly, I assumed the rest to be correct as given in the notes and on a plat thereto attached. From the southeast corner of the five-acre lot I then let fall a perpendicular on the east side of High street. This gave me a right-angled triangle, with all the angles and one side given, to find the other sides. This was readily done. The distance along the east side of High street being taken, a right angle was turned, and a line mostly clear of obstructions was found. On this line the proper distance was measured and an iron stake driven for the corner. This point, where the stake was driven, was found to be some fourteen feet under the platform of a large warehouse and the house itself was almost as much over the line at the south end. The principal object in having the survey made was the party in interest wished to erect a large building, sixty feet wide and extending the entire width of the south lot, at the east end. For this building, however, the ground had been cleared of all obstructions.

But while on the ground the south line of the lot was found by measuring back on the line perpendicular to High street, a dis-

tance as far as could be done without going past that part of the lot cleared of obstructions. At this point a right angle was turned giving as before a right-angled triangle, with all the angles and one side given, the distance on the last perpendicular line being thus obtained, was measured and a stake set in the south line of the lot.

The next thing to do was to divide the lot into two parts of equal areas. This was not difficult to do and all the rest was plain work.

DISCUSSION.

Mr. Lewis: I wish to say if a man who considers surveying dry and uninteresting will read that paper, he will certainly be convinced that it is an interesting vocation. A man must not only be a mathematician, but he must be a detective, geologist and timber expert.

Professor McFarland: I think that a valuable paper. I am old and so is Colonel Innis, and much more than forty years ago I had similar experience in finding corners in Guernsey county. I had to find the hole where the stick had stood. I found it filled with decayed leaves, and that hole told the story. Let me tell you another. In 1859 I was professor of mathematics at Miami University and did practical surveying. I was laying out a turnpike. The boys liked to go along to help with this work because they got good dinners in the country. I did not charge for my work, because I wanted to give the boys practical experience. They worked for nothing and I put in the same bill. On one of these excursions I heard a "horse laugh," and found they were laughing at a man from Allen county. I will not tell you his name—he quit surveying and became a lawyer. The boys were in the habit of cutting holes in the sugar trees to get the sap to drink. This fellow had cut into a big, white oak tree there, and was waiting for the sugar water to run. (Laughter.)

Mr. Cronley: In case of an east and west line fence, which is found to curve six feet to the north at the middle point, what should be done? I had a case of that kind in our county

where the gentleman claimed because the fence had stood there for 25 or 30 years, that was the proper line. Was he right or wrong?

Colonel Innis: He had a right to the ground up to the line fence, if it had been set there for a line fence. I had a case of that kind in Madison township. The fence ran through the center of the section. There was a stone at each end of the line, and when I got about half way from one end, was about fifty feet from the fence line. It had been in occupation for fifty years. I came right to see Judge Baldwin, who was the best real estate lawyer in the city, and asked him what I should do. He held up his arm bent, and said, "I don't care if it is as crooked as my elbow, if it is the line fence it will stand." I told the parties about it. They said they had supposed it was a straight line and had it straightened. The court decisions all hold that it is the duty of property holders to find the true line, and if they sleep on their rights for 21 years, they lose them.

A Member: If he has always contended that it is wrong, doesn't that save him?

Colonel Innis: I don't care how much they quarrel and fight over it for twenty-one years; if they don't go into court with it, it is peaceable possession.

Mr. Cronley: I wish to correct you. I think your statement is wrong about that. My understanding is that if there is a dispute about that line fence—if the gentleman on the north side told the man on the south side that it was not on a line, and he wants it removed to the line, that that saves his rights.

Colonel Innis: The courts have decided that nothing is recognized except a suit at law. (Relates a case in point.)

Mr. Gilpatrick: While it is true as to a line between land owners, the same rule does not obtain in the matter of encroachment upon the streets and highways.

Colonel Innis: Yes, sir; that is true. You cannot acquire any rights by fencing in any part of the highway and the reason is that it belongs to the community and you are one of the community, and ought to look after its rights as well as your own.

THE DISPOSAL OF SEWAGE.

C. O. PROBST, M. D.,
SECRETARY OF THE OHIO STATE BOARD OF HEALTH.

Mr. President and Gentlemen:

The question, How shall we dispose of sewage so that it shall not be productive of a nuisance or injure the public health through the drinking water or otherwise? is receiving much attention from both engineers and health officials. Within the memory of most of us, only the larger cities in America were provided with sewerage systems for the removal of household wastes, and where these were located on streams of considerable size or on large bodies of water, the sewage was gotten rid of without complaint. But conditions have changed and are more rapidly changing, and the old method of turning crude sewage into the nearest body of water must soon be abandoned.

It is to be noted: (a) that the increase of population in our cities is much greater than the general gain; (b) it is now common to find sanitary sewers in villages of 2000 to 3000 inhabitants; that streams which once furnished an abundance of water the year around are now practically dry for several months, and as far as receiving sewage is concerned, the worst months of the year; and lastly (c), that streams are being more and more resorted to for water supplies for our rapidly developing villages and cities.

These new conditions have brought prominently to view the evils arising from stream pollution, and the courts are more and more inclined to interfere with the assumed rights of cities to make open sewers of our rivers. The best engineering skill has been called upon to meet the demand for sewage purification, and the last ten years have given us our best knowledge of the subject.

Too much credit cannot be given to the State Board of Health of Massachusetts for the thorough and painstaking manner in which their experiments in sewage purification have been conducted. In 1888 the legislature of Massachusetts, with that

broad policy which has always characterized the Bay state in dealing with questions affecting the health and happiness of her citizens, gave the Board of Health large powers for protecting the public water supplies, and appropriated a sufficient sum to establish an experiment station at Lawrence, on the Merrimac river, where, under the charge of competent workers, investigations in the purification of sewage and water have since been carried on. The results obtained there have given an impetus to sewage purification which has been felt all over the world. While Europe, and especially England, had been making many practical experiments in sewage purification by the introduction of costly works in various cities, accurate data from carefully observed trials of different methods of doing such work were lacking, and from the lack of such definite knowledge attempts at sewage purification in many instances proved a failure.

Ohio took a step in advance in this direction when, in 1893, her representatives enacted a law providing that no city, village, corporation or person, shall introduce a sewerage system, or public water supply, or change or extend the outlet of any sewerage system, or source of water supply now in use, without submitting such outlet or source of such water supply to and receiving the approval of the State Board of Health. Since that time the board has been called upon to approve outlets of sewerage systems in 30 cities and villages, and has acted upon 38 applications for approval of water supplies.

It has been the constant policy of the board to protect our streams and lakes from sewage pollution, but the public has not yet been educated to the point where it will sustain the board in the position it would gladly occupy of prohibiting in all cases the discharge of crude sewage into water. We believe that time is fast approaching, and we look to the members of your profession for aid and support in bringing about this desirable end.

It is encouraging to note the start that has already been made in Ohio in providing for a better disposition of sewage. Canton, Oberlin, Alliance, the Children's home at Alliance

and the State Reformatory at Mansfield are now purifying their sewage; Fostoria and the Toledo Hospital for the Insane have sewage disposal works under way, and some five or six other places are in consultation with the State Board of Health in regard to plans for such improvements.

It will not be necessary to consider all of the various methods that have been tried with varying success for the disposal of sewage. It will be sufficient to refer rather briefly to the two methods which have proven best in practice, and to point out the limitations of each.

We will speak first of chemical precipitation. In this system various chemical substances are added to the sewage which causes the organic matter in suspension and a part of that in solution to be precipitated, forming a deposit known as sludge.

Following is a brief description of this method: The outfall sewer is usually brought to the power house, where the sewage first enters a screening chamber for the removal of objectionable matter. The sewage then enters an inlet channel which conveys it to the tanks outside the building. As the sewage enters the building it receives—speaking now of the Canton and Alliance plants—a charge of milk of lime, and as it leaves the building a charge of sulphate of alumina in solution. The inlet channel is provided with baffle boards, which cause a thorough mixing of the sewage and chemicals before the sewage reaches the precipitation tanks. These tanks may be of iron or masonry, and of any size or number. At Canton there are four, built of brick, and each 50 by 96 feet in plan, the walls ranging from 5 3-4 to 7 1-2 feet high above the bottom pavement. The capacity of each tank is about 171,000 gallons. The sewage, after receiving its charge of chemicals, passes slowly from tank 1 into 2, on to tank 3, then through tank 4, referring to Canton, and into the creek, which receives the effluent.

About 50 per cent. of the precipitated matters are received by the tank which first receives the sewage; 25 per cent. is precipitated in the second tank, and the remainder is about equally distributed between the other two tanks.

At Canton it has been found necessary, on an average, to remove the sludge from the first tank every other day; from the second tank every third day, and from the third and fourth tanks about once in five or six days. To remove the sludge from a tank it is temporarily cut out of the series and the sewage allowed to rest a few hours. Then the supernatent water is drawn off by a movable skimmer and passes into the effluent sewer. The sludge is drawn off into a sludge cistern from which it is lifted by a pump to a filter press located in the power house, where it is subjected to a pressure of one hundred pounds or more per square inch. The water pressed out gains access to the inlet sewer and again passes through the precipitation tanks. The sludge, in the form of cakes, is dropped into a car standing on a track beneath the filter press, and is carried off for future disposal. At Canton this is hauled away by the farmers and used as a fertilizer.

Various precipitating agents have been used, but chiefly lime, copperas and alum. The amount to be used depends upon the nature and strength of the sewage, and in well-conducted plants this is determined at frequent intervals by chemical examination, and the amounts used are varied to meet the changes in the character of the sewage, which occurs at different periods of the day. The average amount of lime and alum used is from eight to ten grains of lime to two or three grains of alum per gallon of sewage treated, when these are used in combination.

The cost of the works in running order at Canton was $26,-483.76. The running expenses have been about $300 per month.

Canton is a city of about 33,000 inhabitants, and gaugings made some time ago showed about 500,000 gallons of sewage per day to be treated.

The estimated cost of a similar but smaller plant at Alliance, a city of about 9,000 inhabitants, was $18,400.

At White Plains, N. Y., with a population of a little over 4,000, the chemical precipitation works cost, according to Rafter

and Baker, something over $53,000, and the operating expenses have been about $13 per day.

The advocates of chemical precipitation would have us believe that this is an ideal method for the purification of sewage, but, while it undoubtedly accomplishes a very useful purpose, and may in some instances be the only suitable means for sewage purification, there are objections to it which should be pointed out.

In chemical precipitation practically all of the oragnic matter in suspension is removed from the sewage, but only a part of the organic matter in solution.

Mr. Allen Hazen, in a report on chemical precipitation of sewage, made from data obtained by him when in charge of the Lawrence Experiment Station, said: "The best results that we have obtained by chemical precipitation—and we know of no others that are so good—leave as much as one-third of the nitrogenous matter of sewage in the effluent; this is an abundant food supply for the unlimited growth of a large number of bacteria that remain. The number is called large because five per cent. of 700,000, or 35,000, in a thimbleful, is a large number, and, if any of these are disease-producing germs there would be no safety in turning such a liquid into a drinking water stream." (Report of State Board of Health of Massachusetts on Purification of Sewage and Water—1890.)

It is the presence of the comparatively large number of bacteria in the effluent, and of their ability to rapidly multiply in any body of water into which the effluent is turned, which forms the greatest objection to chemical precipitation when such water is to be used for domestic purposes.

As regards the prevention of a nuisance arising from the pollution of streams, it may be put down as a rule that the best results in practice will leave in the effluent from 40 to 50 per cent. of the total organic matter originally contained in the sewage, and the size and character of the stream which is to receive the effluent must be taken into consideration.

At Canton, however, although the effluent is discharged

into a comparatively small creek, no complaint has been made of nuisance arising therefrom.

The objections here urged against chemical precipitation may be completely removed by passing the effluent through filter beds or land properly prepared, before admitting it to streams; but it will often be found much cheaper to resort to land purification at once

In a discussion on the Sewage Farms of Berlin, Sir Robert Rawlinson, K. C. B., late president of the Institution of Civil Engineers, said, "The result of his experience and of all the knowledge he had gained, having served on two Royal Commissions appointed for the special purpose of investigating the sewage question, was that crude sewage in its simplest form, without tampering with it by chemicals, was the best form for the land, and would produce the best results if applied judiciously in proper dilution, in proper quantities and at proper times." Mr. E. Bailey-Denton, one of the highest authorities on this question, in his recent work, "Sewage Purification Brought Up to Date, 1896," says in conclusion: "Excluding from consideration sea-board towns, the sewage of which it may be expedient to discharge into the sea, the instances are few in which the liquid refuse discharged from human habitations may not be more economically cleansed by recourse to land than by any chemical precipitation."

Mr. George E. Waring, Jr., in his work on Sewerage and Land Drainage, 1891, says, in regard to chemical precipitation: "So far as I have been able to discover, the better opinion of American engineers who have given attention to the subject, is fairly expressed by Mr. Benezette Williams, who, in his Hyde Park report, says of chemical and mechanical processes of precipitation, that they are numerous and have had repeated trials in Europe, but without any of them securing permanent recognition as being suitable for general application, when cost and the purity of the effluent water is considered. Such methods are not now being applied in new cases to any great extent, and they have few, if any, advocates of importance."

Turning to the land purification of sewage, we find what

appears to be the natural method for disposing of organic matter, both animal and vegetable. It has been a matter of observation in all times that the soil possesses properties which, when not overburdened, convert organic into inorganic matter, and without the development of putrefactive odors. Until not many years ago this was supposed to be accomplished by purely chemical action, and we spoke of the "oxydation," which was likened to slow combustion of dead bodies or other organic matter in the soil. Later discoveries informed us that this wonderful change from organic to inorganic matter—this passing of "earth to earth and dust to dust," is due to the myriads of minute organisms which inhabit the upper layers of the soil, whose function it is to tear apart the dead, complex molecules which have entered into the construction of plant or animal, and return the elements to old Mother Earth, to be born anew in the ceaseless round of what we call life.

In sewerage purification by land disposal we harness these little workers to our needs, and by their aid effectually rid ourselves of the waste products of our households. But to do this effectually we must have a thorough understanding of the nature of these micro-organisms.

We desire to have at our command in the soil of our sewage disposal beds, as many of these sewage disposers, we might call them, as possible. They require food, moisture and oxygen. Their food and moisture is in the sewage, but their oxygen must come from the atmosphere, as sewage does not contain oxygen. It is for this reason that sewage must be applied intermittently, the air penetrating the filter bed as the sewage passes out of it, and bringing the life-giving oxygen to our little scavengers. In water purification by filtration the bacteria continue to work for indefinite periods, or until the filter beds become clogged, because water contains about two per cent of free oxygen, sufficient to support the life of these purifying organisms, as it does of other aquatic life.

Another reason for the intermittency necessary in the filtration of sewage is that there must necessarily be a limit to the amount of work these micro-organisms can do. If too much

sewage is applied, or at too frequent intervals, the nitrifying bacteria are unable to convert all of its organic matter into inorganic matter, and the sewage beds become clogged and foul, and the effluent is loaded with putrescible substances, and possibly harmful bacteria.

One thousand parts of sewage of average American cities contains only one part of organic matter, one part of harmless mineral matter and nine hundred and ninety-eight parts of pure water. But every thimbleful contains hundreds of thousands of bacteria, some of them, as a rule, of the harmful kind, and dangerous to drinking waters. By passing this sewage in proper amount through soil of proper character, we are able to convert 99 per cent. of this putrescible organic matter into harmless gases and plant food, and to remove 99.6 per cent. of the bacteria. Surely our engineers have now answered this oft-repeated question—What shall we do with our sewage?

The land disposal of sewage has been divided into broad irrigation, intermittent filtration and sub-surface irrigation. The principles involved are the same in all, and there is no longer a sharply-defined line between broad irrigation and intermittent filtration. The land in its natural condition, without underdraining, may be employed in both, and in both the raising of crops may be a part of the plan.

One of the simplest and most successful plants for land disposal of sewage that I have seen is at the Hospital for Insane at London, Ontario. The sewage from all the buildings is delivered to an underground chamber near the boiler house. As it enters this chamber the sewage passes through a screen which removes rags, large pieces of paper, etc. At the other end of the chamber is a sump, towards which the sewage drains, and from which it is pumped. The chamber is ventilated through the smoke stack of the boiler house. Rows of perforated pipes pass about an inch above the floor of this receiving chamber. They are connected with an air pump in the boiler house, and when the chamber is being emptied of sewage the air pump is started, which keeps the sewage in a constant state of agitation. Before this air pump was put in, trouble was experi-

enced from filthy, floating substances adhering to the sides and bottom of the receiving chamber, necessitating frequent cleansing.

It should be noted that there is no sludge chamber. Solid matters are not allowed to deposit, but are pumped direct to the filter beds. The receiving chamber is emptied every day except Sundays, two or three hours' pumping sufficing. The sewage is pumped through an iron force main to a well on one corner of the sewage field. This field is four acres in extent, and is perfectly level. It is laid off in beds ten feet wide, which extend clear across the field, with ditches about two feet deep and three and a half feet wide between the beds. The sewage flows from the well through a wooden trough which passes along one side of the disposal field. The trough is fitted with gates so that the sewage may be turned into any of the ditches at will.

For the first three or four years the field was not planted, but for the last four years the beds have been utilized for growing celery, cabbage, onions and tomatoes, and other garden stuff. Two crops are often taken from the beds, even in this cold climate, and the quality of vegetables raised is much above average.

This field is of medium, coarse sand, underlaid with gravel for a considerable extent. It is underdrained at a depth of five and a half feet, but the effluent seldom or never reaches the under drains. The four acres sufficed for complete disposal of all the sewage, but in order to utilize it all another field of about three acres has been added. This field has worked well without underdraining. The cost of this plant was about $15,000, mostly spent for material.

The disposal plant at Brocton, Massachusetts, completed in 1894, in point of construction is probably the most complete in the United States. It is the intermittent, filtration system, and the plant is much like that described for London, Ontario, though a much larger one.

The sewage is pumped from the receiving reservoir to fields seventeen hundred feet distant, laid out in twenty-three filter beds, each an acre in area. The soil varies from fine

gravel to very fine sand. Excellent results have been obtained here. The cost of this plant was $209,771.52, and it is most complete in every way.

Only the briefest allusion will be made to the sewage farms of Berlin, in order to show that the largest cities may resort to land for sewage purification. The farms contain about nineteen thousand acres, and to reach the various fields, sewage has to be lifted from 54 to 115 feet. Every attention has been given to utilizing the sewage, and a small profit has been made on the investment. During the year 1890 nearly thirty million gallons of sewage were cared for daily, including all storm water.

As already indicated, a porous soil is essential for the successful disposal of sewage on land. The air must be able to penetrate it freely so as to furnish the oxygen essential for bacterial action. If the material is too coarse, the sewage is not retained long enough for the necessary changes to be brought about; but the purification of sewage is by no means a simple, mechanical or straining process. Excellent results may be obtained by filtering material as large as pea gravel. All that is necessary is that the sewage should be spread out in thin layers and exposed for not too short a period to the action of the nitrifying bacteria. In some places the natural soil, without other preparation than surface grading, will accomplish this. In other places porosity of the soil must be in reased by underdraining, the depth and distance apart of such drains being arranged according to the character of the soil.

The quantity of sewage applied per acre, and the frequency of its application, must be governed by the kind of soil. In some cases it may be best to give a given area a week's allowance in one or two applications, while in others the best results may be had by applying the sewage daily. Experience has shown that with soil of proper character, it is possible to continuously purify the household sewage of one thousand people on each acre of filtering area. In practice a less number, about five or six hundred, is provided for, and with poorer soil the number would be still smaller. We may be able, by thus

increasing the filtration areas, to make use of land which is not the most favorable for sewage purification.

But in many places we may not be able to find available land which is at all suitable for sewage disposal. Even here it may be better and cheaper to construct artificial filter beds than to resort to chemical precipitation.

An interesting experiment in this direction is being made at Fostoria, Ohio. The soil there is of a retentive character and not well adapted for sewage purification. Filter beds are being constructed by underdraining to a depth of five and a half feet, the ditches for the drain tiles being two feet wide and sixteen feet apart. About two feet of the top soil is stripped off, being used for the embankment, and is replaced by two feet of gravel, which, delivered at a distance of one and a half miles, costs fifty cents per cubic yard. The ditches are filled with the gravel, and sewage, when applied, will filter horizontally, and perhaps to a slight extent latterly, through the two feet of gravel, and will then flow latterly, and mostly on top of the soil, as I conceive, until it reaches the underdrain ditches. It will then pass down through three and a half feet of gravel to the underdrains.

Before the sewage is delivered to the filter beds at Fostoria, it will be received in precipitation tanks, which will allow a portion of the solid matter to be deposited, and will then pass upwards through a rough filter of coke and broken stone, one and a half feet thick.

If this method proves successful, and there are good reasons for believing that it will, a way will be pointed out for the purification of the sewage of towns unfavorably situated as regards the character of surrounding land.

Some experiments which have lately been made at London, England, on the rapid filtration of sewage through coke breeze, deserve attention. Coke breeze is the screenings of commercial coke and is worth, F. O. B. cars, about $1.50 per ton.

Mr. Dioden, chemist to the London County Council, experimented at Barking with a coke filter one acre in area, con-

structed of three feet of coke breeze, with three inches of gravel on top to keep the coke particles from floating out of place. He was able to pass sewage continuously through this experimental bed for six months at the rate of one million gallons per day, and remove seventy-five per cent. of its organic impurities. This, you will note, is a much better result as regards the reduction of organic matter than has been accomplished by chemical precipitation.

I regret that I am unable to report upon the bacterial purification accomplished in this very interesting experiment, but no account was taken of this in the reports of the experiments which I have been able to find.

In any form of land purification of sewage, care must be taken that the sewage is properly distributed, and in amounts suitable to the land to which it is applied. If this is not done failure is likely to follow; and every effort should be made by the engineer who plans the works to have a competent person placed in charge. The engineer should make a careful study of each portion of the filtration area and should provide written rules governing the application of sewage. Chemical and bacteriological examinations of the sewage effluent should be made at intervals, and such modifications in the working rules should be made from time to time as practice and these examinations show to be necessary.

In conclusion, permit me again to express the hope that this Association will join the State Board of Health in endeavoring to prevent the pollution of our lakes and streams by material which, it is hoped has here been shown, can be cared for at reasonable expense on land with benefit to all.

DISCUSSION.

On motion of Mr. Judson, a vote of thanks was extended to Dr. Probst for this paper.

Mr. Gilpatrick: I would like to ask Dr. Probst what solution he has, in connection with this filtration system, for the relief of small towns; towns, say, with a tax duplicate of three to five hundred thousand dollars; where the natural contour or

topography of the town will save the expense of a pumping system and will carry the sewage to where it is to be placed; but still the expense necessary for a plant of that sort is too great for the town?

Dr. Probst: We cannot have sewage disposal without money; but a town that can afford to put in a sewage system can afford to put in a sewage disposal system. Where it can be delivered by gravity, it can be put in at little expense. At Providence, they have five or six institutions collected on a hill, and there the sewage passes through a wire basket which acts as a screen. It runs through a brick channel and flows off to the various places through underdrains, to places planted with grain. So if you have suitable ground at your disposal I think it could be done very cheaply.

Mr. Gilpatrick: We were before the Board of Health and this question came up. We wanted authority of the Board of Health to turn our sewage into a stream, and it was reported back as not legitimate. So there we are left high and dry. We have our sewage, but have no means of disposing of it. We have not money to build a system, and there we are stranded.

Dr. Probst: Why not do it as they did at Lima; do it anyway.

Mr. Gilpatrick: The point I make, Mr. President, is that I believe the time very soon will come when the state will have to come to the rescue of towns like this in the matter of disposal of sewage. The state must come to the rescue and furnish means to take care of the sewage of such places. This is radical, and perhaps revolutionary, but a thing, I believe, which must come. I am expecting to hear the State Board of Health advocate that some day; I rather hope it will.

Mr. Snow: I would like to ask if it is practical to mix the heavy clay soil with coal ashes instead of sand or gravel, so as to make it cheaper to make a bed in that way?

Dr. Probst: I do not know that I can answer that question. I believe so. Experiments have been made by mixing ashes with clay soil in England, getting fairly good effluent. I think it better to build filter beds, though it might cost more.

Chairman Strawn: Would it not be better not to put any clay in at all? Would not the clay tend to clog instead of help filtration? It rather seems to me that this matter of inability to build a sewage system is a matter of fancy rather than fact. The people think they are not able to pay the tax for this purpose, but if there is sickness they furnish a doctor, or in case of death pay the undertaker's bill. And the tax to furnish sanitary improvements is not nearly so much.

Mr. Williston: Will not this method of sewage disposal, in the way of increasing the fertility of the land used, partially offset the expense of preparation of the beds?

Chairman Strawn: I think Dr. Orton answered that question very fully last year at Dayton. He stated that the real value of the sewage sludge was about five or eight cents a ton.

Dr. Probst: As I stated in my paper, Mr. President, the farms in Berlin had paid a small profit on the investment, about one and a half per cent. A few English farms have paid a small profit on the investment, also; but you must not depend on getting very large returns from the sewage disposal. Massachusetts now has all the sewage farms planted in corn, and where raising sewer corn they get better prices in the market than the farmers can get who raise it elsewhere.

Mr. Gilpatrick: What is the value of this sludge furnished at Canton?

Dr. Probst: It is worth very little. At many points in England they are obliged to burn it in order to get rid of it.

A FEW THINGS ENGLISH.

EDWIN D. HASELTINE, YOUNGSTOWN.

My stay in the British Isles last summer was of only four weeks' duration; and as it was a health excursion rather than a sight-seeing one, I did not gather together sufficient interesting data to make near so good a paper as the subject warrants. In the article that I prepared for the "Ohio Institute of Mining Engineers" I wrote up all the more interesting things seen, so this one is necessarily composed of odds and ends left over, like a 2d of January or 5th of July dinner. As this paper is to be something like a random line, we may as well begin at one point as another and will start with the railroads. Their gauge is the same as ours; trains all run on the left-hand tracks; locomotives have no headlights, no bells, no seats for the "drivers" and almost no cabs. They are smaller than those in general use here. Roadbeds are very good, but no better than on the best American main lines. Broken stone ballast is almost universally used. Ties are spaced about two and a half feet from center to center; the rail does not rest on the tie, but on an iron chair, having a lug on each side that extends almost to the top of the rail, and a wooden wedge is driven in on each side of the lug. Lead rails are unusually long; switches in the yards are thrown by the Saxby & Farmer system of switch towers, imported from the United States, so also is their system of "Semaphore" signals. Freight cars range in capacity from 7 to 10 tons; they stand on four wheels and have lever brakes similar to those on coal bank cars. On main lines the limit of curvature is about 30 chains, on sidings and branch lines it may be as short as 10 chains. All the distances given me were expressed in chains and links At each change of grade there stands, just outside of the ditch, a post about two feet high, having two arms on it. The grade is marked on these arms, and their inclination shows its direction. The grade is expressed in the number of lineal feet to one foot raise. One in sixty-seven was the steepest noticed. Viaducts and bridges are nearly all built of stone, and appeared to me to

be unnecessarily heavy, considering the weight of the rolling stock. There is a viaduct near Marple, England, that consists of ten or twelve stone arches not less than 75 feet high. Ivy, that grows so luxuriously there, has covered most of it with its bright green mantle, adding much to its beauty. Station houses are all good, and at nearly all stations trains are under cover. They are built double, that is on each side of the tracks there is a complete station house, with a full compliment of booking offices (ticket offices), lavatories, luggage offices, etc.

Communication from side to side is had by means of overhead bridges or subways. The depot floor is level with the floor of the cars, the construction of which I need not describe, as it is no doubt familiar to all of you, but a person who has never traveled in one of them has no idea of their inconveniences. The lack of water closets is particularly annoying, and riding in a little stuffy compartment, with your knees knocking against those of the passenger opposite, is anything but pleasant. They claim that by having side doors they are able to handle passengers more quickly than by our plan of a door at each end of the car, but I am of a different opinion. The various classes of compartments are not arranged in any regular order; first, second, third class, ladies only, first class smoking, second class smoking and baggage vans are mixed indiscriminately through the entire train. When a station is reached, people run backward and forward along the train looking for an empty compartment of the required class, and they, together with those who have alighted and are claiming their "luggage," make such a confusion, that more time is lost than would be if they had end doors and a system of arranging the various classes of compartments in regular order.

Everyone must be his own baggagemaster to a certain extent, and traveling in a country where you are required to act in that capacity, without checks, will make a man gray headed. Suppose you are in a hotel and wish to go to another city. You go to the head porter, a man of considerable importance, give him a sixpence and tell him that you want your luggage brought down. He will call a second porter, who will bring it down and

call a carriage for you; give him a sixpence. When the depot is reached, the driver does not get down from his cab, but you find, not the baggagemaster, but a porter; tip him and the driver a sixpence each, tell the porter where you want to go, and he will paste a tab on your "box" that has on it only the name of the town to which you are going. See personally that the trunk is put into the proper van, and when the destination is reached, run and see that it is put off, claim it and take it away, or it will be immediately put into the "lost luggage" room and reported to headquarters as unclaimed. If so reported you are required to sign a receipt and pay a fee when claiming it, but under ordinary circumstances you simply say, "Porter, that is my 'box,' here is a sixpence, call a cab." A person has absolutely nothing to show that he ever had a trunk, and when it is lost, as mine was, you simply describe it and have the agent telegraph for it till found. By the way, a twelve-word message costs only a sixpence, twelve cents.

Time tables might as well be written in a foreign language, they are utterly unintelligible, even to the natives.

As you know, they have almost no grade crossings in England; I noticed but one, and there they had guard gates about six feet high, but as the required height is only 14 feet and 6 inches, over-head bridges are neither very costly or objectionable to wagon road travelers. Speaking about the highways, they are simply superb, smooth as an asphalt pavement and as hard as flint rock. The usual width is from 18 to 20 feet, with a stone wall on each side. The paving extends clear to the wall, which answers the purpose of a curb for the gutter. Foot passengers, bicycles and vehicles all travel in the same track. The road from Mauchline to Montgomery Castle, in Scotland, is not less than 50 feet wide; along most of the way trees have been planted on each side, and at every half mile or so a good seat is placed under some wide-spreading tree, a resting place for the weary pedestrian. Mile posts are of stone, about two feet high, triangular shaped, with an apex toward the road and the distance to the nearest town neatly cut on the faces. Where the railroads cross above the highways many beautiful skew arches, usually of

brick, are to be seen. Repairs are constantly being made and broken stone in piles of about a yard square can be seen along the roadside at every few rods. Old men with hammers break them to the required size and spread them on the thin places. Formerly it was left for the travel to wear them smooth, but now it is done with steam rollers.

In cities brick, stone and asphalt pavements are to be seen. Those of London are largely of wood, very smooth, noiseless and in excellent condition. They are cleaned by hand. The crown, height of curb and proportionate width of sidewalk are about the same as those in general use here.

The water of Glasgow is justly famous; it is clear, cool, very palatable and the purest furnished to any city in the world. Loch Katrine, from which it comes, is surrounded by Mountains covered with heather and grass, but no trees. They have most rigid rules relative to polluting the water, and no more than ten or twelve houses are situated within its entire water shed. The level of the lake has been permanently lowered about two feet since the city commenced to use its water, but does not seem to be going down any more. However, many complaints can be heard about the loss of that two feet. I did not think to taste the water of London before ice was put into it.

Street cars are nearly all drawn by horses; they usually are double-deckers, with a cheaper fare for the top deck. In Edinburgh, Scotland, they have some new cable lines, but I saw no others. In the part of London that I visited they had no street cars of any kind, those who did not go by the underground railroads rode in double-decked omnibusses, that were drawn by the finest lot of large horses that I have ever seen, and a pair of them would jog along with a coach full of passengers as if it did not weigh half a ton. Having so many they are able to mate them well; they are fat, and I did not see a single lame one.

The streets are full of these busses all the time, 78 of them passed the Charing Cross Hotel in 10 minutes by actual count, and at the corner by the Bank of England they are much thicker. There are no end of hansoms and cabs. I saw one numbered 17,820, and it did not look very new either.

They will not allow wires to be strung in the streets, consequently have no electric lines of street cars. There was one in Ireland, advertised as being the longest electric line in the world, running from Port Rush to the Giant's Causeway, a distance of 8 miles; but they killed a man, so down came the trolly, on went the horses and that ended electric street car lines in Great Britain. Fares are regulated by distance, and although you can ride for a penny, if a person is going far it costs more than in the United States.

As to buildings, you wonder at their stability and that is all. Three and four stories are the usual heights, and a six or seven-story building is seldom seen. However, they are well built; we saw some two and three hundred years old that looked good for another century. Government inspectors examine the plans and the construction of every one of them, both for stability and sanitary arrangements. I asked how it was that in the central part of London, along Regent, Pall Mall, Piccadilly streets and The Strand, where land is so very valuable, they did not remove the old low buildings and build modern sky-scrapers in their places. I was told that it was because only a small part of the land was owned in fee simple; most of the buildings stand on leased ground, are owned by estates, or subdivided among different branches of a family where multiplicity of owners and conflicting interests make improvement impossible. And also because the English love old things and are loth to change to the new. All buildings are of brick or stone; we saw but one frame building while there. A few shingle roofs can be seen; there are many slate ones, and the old-fashioned straw thatch is no rarity.

One of our greatest conveniences, the elevator, is not in general use there; many large hotels have no "lift" and you climb up and down stairs in stores that cover acres. The great stability of the buildings prevents elevators from being put into those already built; they say it is almost impossible to do so without tearing them down.

Fences are usually hedges or stone walls, although there are some American barbed-wire ones. Along railroad hedges

are the usual thing. Walls are from four to six and a half feet in height, usually the latter; they are about two feet wide at the bottom and one foot and a half at the top. Their mortar is remarkable; I do not remember of seeing a single place that even needed pointing. Along railroads the banks are all sodded; hay was being made from them when we were there, and cocks of it dotted the slopes everywhere, in marked contrast to the piles of weeds and brush so common to the roadways of most American railroads. For the benefit of those of you who are interested in farming I will digress to say that it takes from four to ten days to cure the hay, and has reached six weeks. When it is cut the stubble is as green as our grass is in May. They raise phenomenal crops of it, the stacks are as thick as the cocks are in some of our meadows.

The Clyde is a small stream, and as it receives a great deal of sewerage, when the tide is out it smells very badly. A New Yorker going down it on an excursion boat, boasted to the captain of the size, depth and beauty of the Hudson. "Oh," said the gruff Scotch sailor, "God made the Hudson, but Scotchmen dug the Clyde." They made a good job of it, too, but large boats can go up only when the tide is high.

In joint stock companies each stockholder has one vote, and one only, no matter how large his holdings may be. They have introduced a little of American financiering into their methods of getting around objectional laws, and those who hold large blocks of stock transfer shares to enough of their relatives to give them control of the business.

What impressed me the most? The beauty and cleanliness of the farm lands, and the country generally. Look anywhere you will, it is just like a park. No weeds fringe the roadsides and fence rows, the stumps are all gone, thorn bushes have been cut down, there are no unsightly piles of refuse around the factories, in fact the country is finished. Our farmers might well learn a lesson from them, but as they pay 3, 4 and 5 pounds annual rental per acre, they are forced to cultivate to the last foot.

There are not many startling things to be seen in the British Isles, and it is well worth one's time and money to go, both for the education gained, and for the satisfaction you feel with the United States when home again.

REPORT OF COMMITTEE ON HYDRAULIC AND SANITARY ENGINEERING.

CHAS. A. JUDSON, CHAIRMAN.

The term, hydraulic engineering, while defined as embracing the invention and development of hydraulic machinery and appliances, and the improvement and control of streams, navigable waters and canals, as it includes the construction of works not only for the supply of water for the use of cities and towns, but also works built to convey away, in some suitable manner, the refuse, must also include, very properly, the term sanitary engineering. For the building of water works and sewers, if they are properly designed and constructed, conduce in a marked degree to the preservation of the health of the communities in which they are placed; and unless they conform to the principles of sanitary science, they fail to accomplish the ends for which they were intended.

We are impressed when we study some of the greater works of this branch of our profession. We note with pride such monuments of engineering skill as the recent "Opening of the Iron Gates of the Danube," requiring the removal of more than 800,000 cubic yards of rock, much of it under water, with a million cubic yards of masonry in dams and walls; the Manchester ship canal, which required the removal of 53,000,000 yards of material, 12,000,000 yards of it being rock; or our Chicago drainage canal, with its more than 12,000,000 cubic yards of limestone, excavated in a space of time that, twenty years ago, would have been thought impossible.

But, though these engineering feats amaze us, we are no less impressed with the importance of the municipal part of this field. We learn that in 1890, 269 cities in the United States, with a total population of fifteen and a half millions, obtained their water supply through 16,000 miles of water mains, costing more than $350,000,000 to construct.

But we are not more impressed by the large amount of

money invested in these vast works than by the fact that, upon the proper conduct of these systems, so many millions of people depend for their comfort and safety. No one, when he reflects upon these things, can fail to be struck with the great responsibility of the engineer in connection with them.

He is entrusted with their design, which he must adapt to the special needs, surroundings and circumstances of each community. He it is who supervises their construction, that the purpose of the design may not be defeated by ignorance or fraud. When special appliances are needed for working out the details, he invents them; and, finally, when the works are completed, he is often called upon to manage them.

While the foregoing observations may seldom, if ever, apply to the same individual, you all doubtless know that they apply to the profession itself.

It follows, then, that it is essential that the designs should be the best, not only because they involve the health, happiness and general well being of the people, but because these ends ought to be attained in the most economical manner. Certain qualifications, therefore, are demanded of the engineer who seeks to add to the happiness of a community by designing for it a system of water works or sewers.

We say that first he should have a thorough knowledge of the principles involved. Not only in the chief problems themselves, but also in the minor, though hardly less important ones, that are bound to confront him with surprising frequency. For though he often needs to modify his formula to fit different conditions, it is equally certain that the one who trusts to the "rule of thumb" to get him through the maze, is certain to stumble.

A second qualification for this very important work is the experience necessary to supplement and modify his theoretical knowledge. By experience is meant familiarity with the practical application of the chief principles involved, obtained partly by working under the plans of others, and partly by independent study and observation. You have found that, in the general practice of your profession, you are often compelled to rely upon knowledge gained chiefly by experience; but in the design and

construction of systems of water works and sewerage, this form of knowledge is doubly needed.

For example, in providing a source of supply for a water works system, you often have to solve the problem "available rainfall" in the vicinity. This depends on several things; as, (1) evaporation; (2) percolation; which in turn depends largely upon the character of the soil; (3) porosity and dip and topography of rock; all of which conditions vary, of course, in different localities, and require special study.

Another familiar problem is the allowance to be made for growth in population. We find, by referring to the late census, that while the increase in the entire population from 1880 to 1890 was 24.86 per cent., the growth of the city population was 60.46 per cent. At what point between these two limits does the community in question belong, taking into consideration its character, as a commercial, manufacturing or residence city?

These are samples of the variables with which the engineer must solve the problems, and they indicate to the thoughtful mind the necessity of care and preparation.

A third qualification needed by the hydraulic engineer is the ability to cope with municipal boards and other organizations that have to do with public works. This requires a knowledge of human nature, plenty of tact and some knowledge of politics in the best sense of the word. He will find that his difficulties in this direction divide into several classes.

First, there is the member who has a hobby which must be noted and which he is bound to ride; and there is always present, to a considerable extent, the desire to experiment, because the expense of failures, instead of being paid by the officials themselves, is borne by the public. Another difficulty is found in the ignorance of many who occupy these important positions; this feature requires much attention, and yet is not of itself so serious a thing to overcome. Occasionally we meet with corruption, and often with that spirit of favoritism which makes the enforcement of specifications so difficult.

Some other difficulties might be mentioned, but enough have been cited to remind you that to overcome them requires a

good measure of ability in this line, also, on the part of the engineer.

Finally, the engineer of this branch of the profession ought above all others of his fellows, to appreciate and have respect for the dignity of his calling. He is entrusted, to a considerable extent, with the well being of thousands of human lives and millions of money, and this thought of itself ought to fill him with deepest respect for his calling. He can himself increase the respect of others for the profession by doing work of a high order.

Preparation, careful study and integrity will usually master the difficulties; but if, at any time, the engineer is in doubt about essential points, and believes that the interests of the community demand more light, he ought not to hesitate to make the facts known and ask for consultation with those of more experience, or who are better equipped in this special line. Physicians and lawyers do this without losing standing, why should not we?

The engineer can also increase the respect of others for his calling by refraining from unprofessional conduct. In no other branch of engineering is there so much laxity in this respect as in the one we are considering. Hydraulic and sanitary engineers are springing up on every hand, where, but a short time ago flourished modest surveyors or city engineers, and there is danger that professional courtesy will be neglected in the hustle for business.

Much of the engineering work for both water works and sewers is now done by the lowest bidder; and often, because he has taken the work so cheaply he cannot devote sufficient time for the production of the best plans or for securing the best construction. The result cannot but be harmful to the profession. We cannot raise the standard until engineers cease to fight each other and are willing to concede a fair division of the work. No engineer in this day can hope to master all branches of his profession. There is no good reason why we should not have specialists in the broad field of engineering as well as in medicine and law.

Again, it would aid in elevating the standing of the engineer in Ohio if an engineering department were added to the organiza-

tion of the State Board of Health, as is the case in Massachusetts. At present our board is restricted in its authority to the consideration of the sanitary features of plans for water supply and sewage; they should have authority to pass upon the engineering features of the plans as well, which would of itself insure a higher order of work.

Another argument for a competent engineering bureau, who shall supervise such plans all over the state, is found in the general ignorance of the public in regard to engineering questions, and also in regard to the competency of the engineers employed.

But we are progressing, and it is coming to be recognized that the knowledge of the competent engineer is worth something, that his very training makes him an efficient and economical manager of many enterprises. It is stated that railroad and manufacturing corporations that have followed this policy are prosperous; and, that in case of the largest and richest railroad in the United States, almost all of the general officers, including the president, are trained engineers.

We find, then, that the engineer can and ought to occupy a higher plane with the general public than he does, and that his present condition is due to his own conduct. The way is open and very plain. "By their works ye shall know them" is as true of the engineer as of any other man.

DISCUSSION.

Mr. Gilpatrick: The suggestion made in regard to having engineers as members of the State Board of Health is a matter that occurred to me this afternoon. I wish some action might be taken whereby some such arrangement might obtain. Certainly physicians are not able to give necessary information or impart decisions touching the feasibility of systems of water works or drainage; and if the law does not permit of the appointment of engineers to membership of this board, it ought to be amended so that this might be possible.

Mr. Judson: It seems to me if the law is amended so as to provide for an engineer upon that board, it would also be necessary to give the board additional authority. As it now is, they can only consider the sanitary feature of the proposed source of supply, or in case of sewers, of the disposal of the sewage.

OBSTACLES OVERCOME IN SEWER CONSTRUCTION.

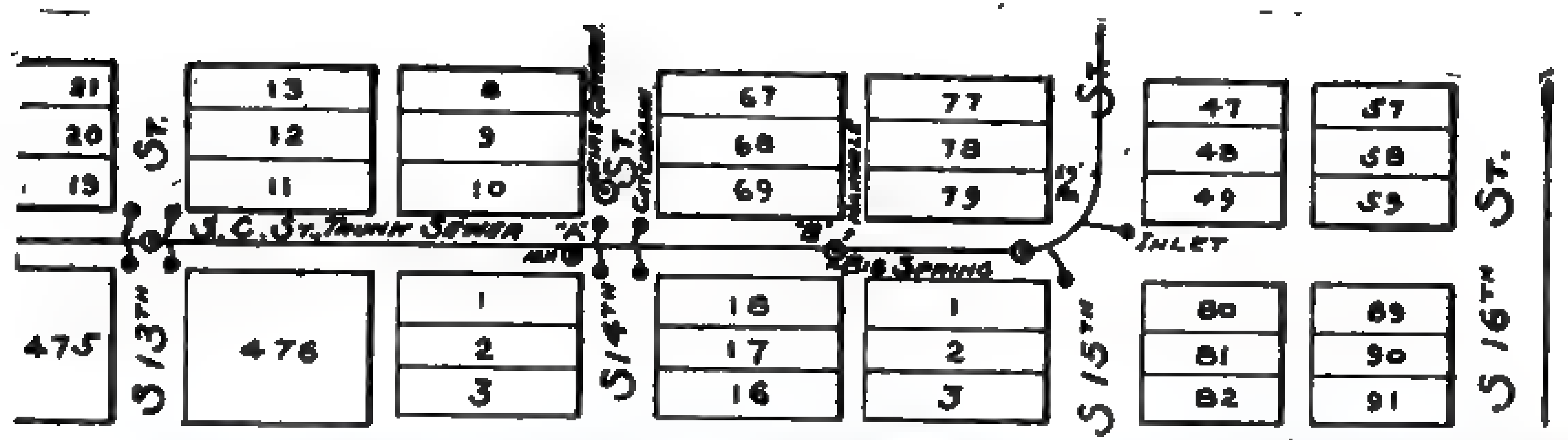
H. L. WEBER, RICHMOND, IND.

Many are the obstacles to be overcome in sewer construction, from the time when the idea of a sewer system is first conceived in the mind until its final completion on the ground. It is not my intention to enumerate all of them in this paper, neither would it be possible if I had such a desire. Each case presents its own obstacles, and it is the business of the Engineer to find some practicable way to overcome them, or they will overcome him. The saying is, "Every dog (of us) has his day," but we feel sometimes as though there were not dog days enough to go around. It seems as though real obstacles are oftenest met with, when we are searching deep down in mother earth after that mysterious thing called the "grade line," that the engineer has located so low, and especially does it seem low and hard to reach when the price is on a correspondingly low grade. Then are all obstacles distressingly real, and they are usually encountered when they are least expected, and when the contractor is least prepared for their reception.

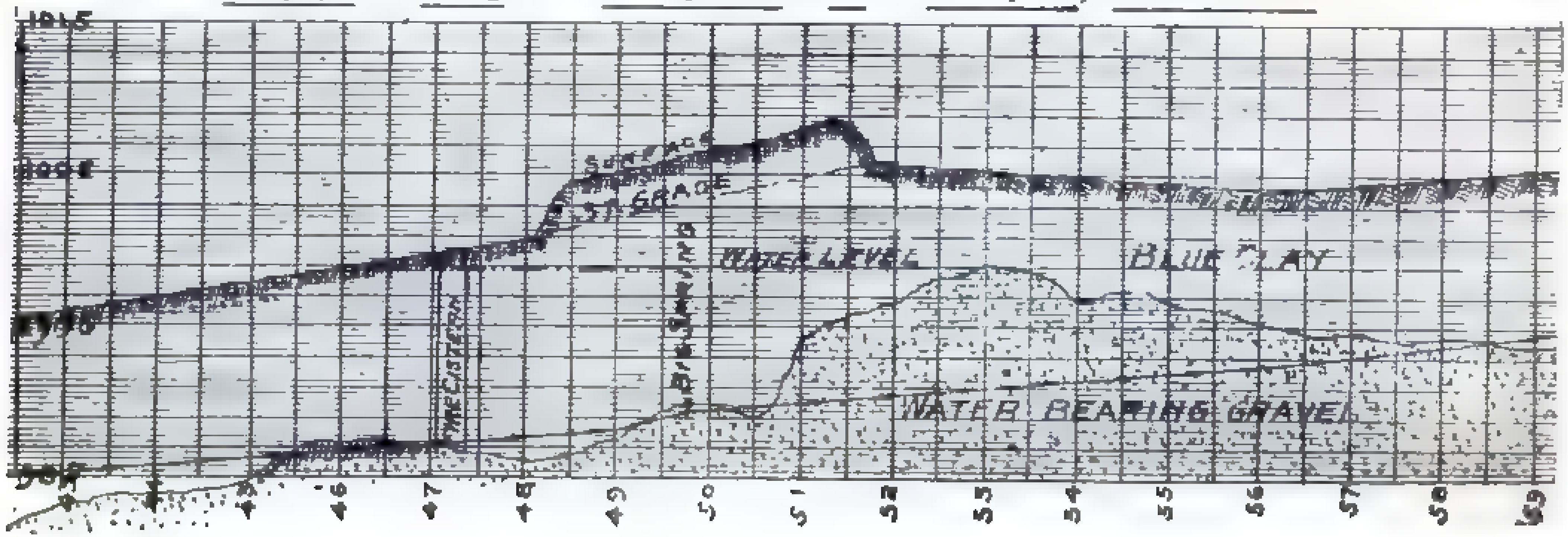
At Richmond, Ind., we have all the variety of material to dig through that you would ever care to encounter; black loam, yellow clay, marl, sand, gravel, bowlders and a stratified limestone rock in layers from 1" to 10" in thickness, with a layer of blue clay from 1 inch to 1 foot thick between the layers of stone. All of these you are liable to encounter in a distance of a few hundred feet, and all except the rock are found in any of our sewers. But the most difficult obstacles we have to contend with is water, which is the "bone of contention" in our sewer construction, and the principal theme of this article.

In the fall of '94 we were constructing the outlet to "the Linden Hill Sewer," and in its path we struck what we at the time termed "The Big Spring."

We had been expecting to strike water, but nothing like what we found. The flow was 935,000 gallons daily, which we let run for several days, expecting it to reduce in volume and give

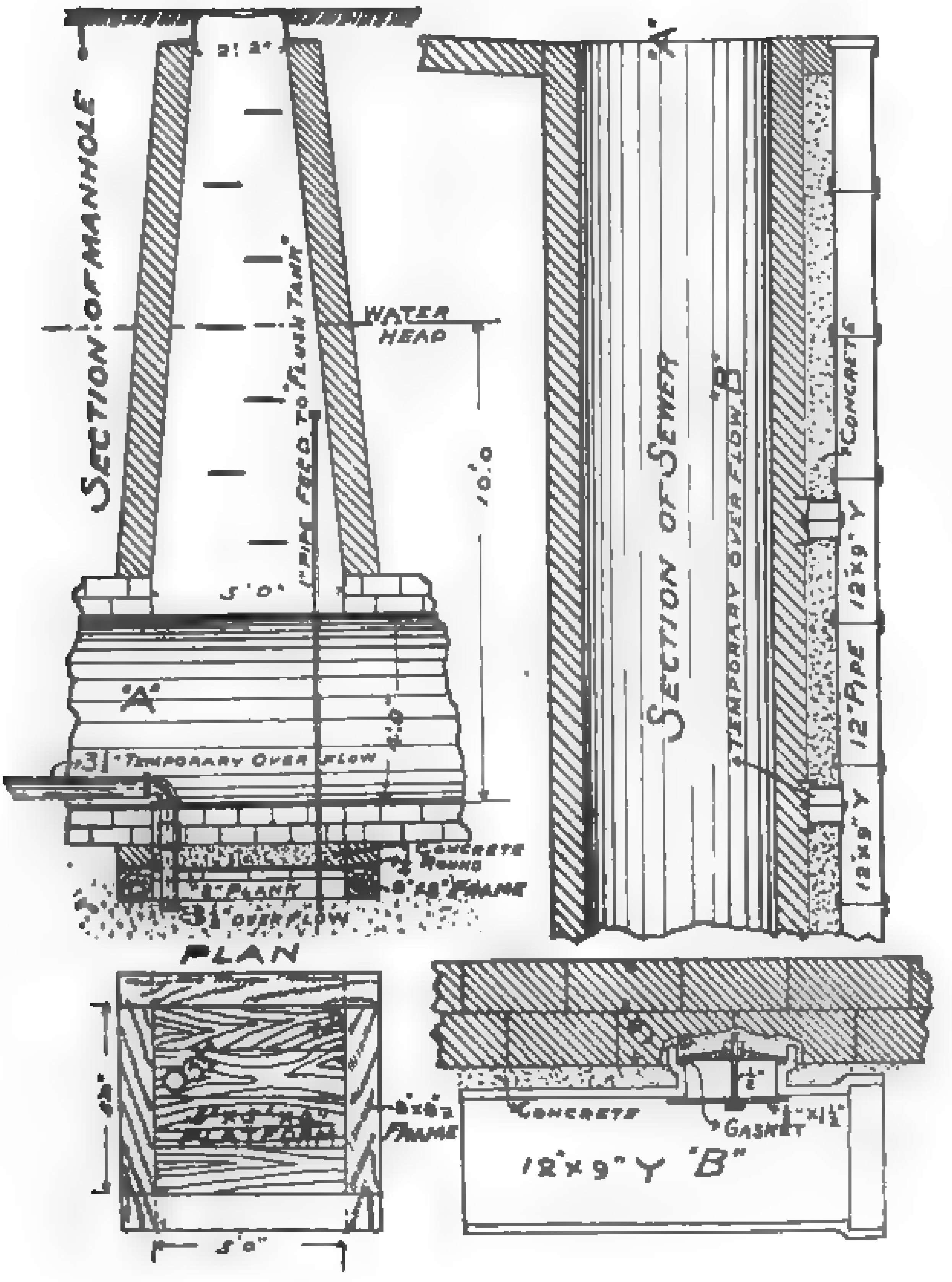


— PLAN AND PROFILE OF S C, St, TRUNK SEWER —



us a chance to catch our breaths, but as it did not decrease to any great extent we found it necessary to resort to heroic measures. The brick work was about 100 feet in the rear; a rise of .7 was made in the grade, and a subdrain of 12-inch sewer pipe was put in with nine-inch T openings at intervals of 10 feet, as shown on the plans. A bulkhead was then built at the "spring" and the water carried over by a flume to the sewer, about 100 feet, while the subdrain and brickwork was being constructed, and until the cement had set sufficiently to allow the water to run over it. The brickwork and subdrain was carried as close as possible to the spring. Then the bulkhead was removed, and we put in a 6-inch centrifugal pump, which was operated by a traction engine to its full capacity. A steam fire engine was placed at sump well "A," throwing two 2½-inch streams, and the 12-inch subdrain was connected with the spring. The 6-inch pump was placed 2 feet below the subgrade of the sewer and the pipe emptied about 15 feet from the spring into a flume, which carried the water about 100 feet down the sewer. The total lift of the 6-inch pump was only 4 feet, so its capacity was enormous. A frame was made 5x5 feet square out of 8x8 inch oak, and settled to a point 1 foot below grade. The brickwork for the pumpwell (which was afterwards made a manhole), began on it and was built to a point about 1 foot above the top of the brick sewer. The pumps and drains were kept in operation until the brickwork was completed 150 feet above the spring. The subdrain was also carried to this point with the outlet emptying into the pump well. Then pump well No. 2 was built in like manner. After the brickwork was completed, a plank bottom was made of 2-inch stuff, 5x5 feet square with a 3½-inch pipe overflow, as shown by plan. This with some difficulty was settled to place in the frame and a quarter round cleat nailed around the edge to keep it down. The joints were then caulked with jute gasket and the bottom covered with concrete, upon which the bottom invert was laid and the flow line made continuous. After the concrete and bottom or outside ring was laid and the cement properly set, the pipe of the overflow was uncoupled and a cap placed on it, after which the inner ring was built. After this was completed,

SECTION OF MANHOLE & SEWER AT BIG SPRING



the 12x9 inch Ts were stopped by placing an iron stopper, and filling the opening in the brickworks as shown by the plan. The water in about three weeks rose to its original height, and I was agreeably surprised to find that we had effectually shut out the water from the sewer with the exception of some little streams about the size of straws, which were then successfully caulked.

Louisville Black Diamond cement was used through all the work and very freely, especially through the wet place. After the subdrain pipes were laid, gravel was placed around them to their tops, upon which was placed the concrete whereon the brickwork was commenced. At the big spring (Manhole "B") a 1-inch pipe was built in the corner of the manhole and carried to a height sufficient to deliver water to an automatic flush tank, which we will build when needed.

Our sewers all empty into the Whitewater river, and on account of the topography of our city it is impossible to confine them to one outlet, except by the aid of an intercepting sewer. Our system is on the combined plan, and has been on the way for many years, and like Joseph's coat, is made up of many different kinds of material, workmanship and engineering. Our minimum sewer grade is .5 foot per hundred feet, with the exception of one or two, which are .33 feet per hundred feet, while in some places they run from 10 to 30 feet per hundred feet. Three feet per hundred feet is a very common grade.

In West Richmond we have stone within a few feet of the surface, and generally have to go from one to ten feet into it in making sewers. It is very difficult material to handle; much more so than if it were solid rock. Drillers are paid 15 cents per lineal foot for drilling. It cost about $2.25 per cubic yard to handle this material. The rock runs in layers from 1 inch to ten inches thick, interlaid with a blue clay, which, in many cases, has to be blasted and often cannot be blasted successfully. Geologically, this rock belongs to the "Cincinnati group" in the Trenton period of the Lower Silurian. The Trenton period is remarkable for its extensive limestone formation. The Cincinnati group comprises the latter part of this period, and its rock in New York and the Appalachians is shale and sandstone, while in the interior

basin around Cincinnati and Richmond the limestones are often clayey and impure. These rocks are very rich in fossils. During the first part of this period, this interior basin was doubtless a clear shallow sea, densely populated with corals, brachiopods, trilobites, crinoids and other life of the era. During the latter part of the period, or the Cincinnati epoch, which includes our formation, this sea became more open to sediment, through some change of level or of the coast barriers, and this is the cause of our thin layers of rock, interlaid with deposits of clay and other impurities. At the same time, the former life disappeared, and other kinds more adapted to impure waters and muddy bottoms took their places. Richmond and vicinity affords a very interesting field of observation for the geologist. The locality is exceedingly rich in all the fossil life of the period. It is celebrated among geologists all over the country on this account, and many a pilgrimage is made hither for the purpose of examination and investigation. The formation possesses many peculiar and interesting features. The Whitewater river lies at the bottom of a gorge from 40 to 100 feet deep which it has cut for itself through the rock. In constructing our sewers, when we come to a point a few hundred feet from the river, the rock suddenly drops off, leaving a channel or depression from 60 to 260 feet wide, filled with drift materials, gravel, loam, etc. This was the ancient bed of a prehistoric river, which lay about 600 or 700 feet west of the present river, and in its general course is nearly parallel therewith. Many springs of good water are found in this old channel. For about 200 feet from this bed, the surface of the rock, which here is found about 6 feet below the ground, is worn into a series of wave-like ridges, from 1 to 3 feet across, and planed as smooth as glass by some powerful agency, which was at work long ago, probably before the members of this Society were regulating the face of nature. These ridges are parallel, and run in a course of about S. 45 degrees W. Passing through this channel we encounter some more "obstacles" in the shape of a large and varied collection of bowlders of assorted sizes, from those as large as a man's head to those as big as a smoke-house. Some of these are too large to take out whole, and

are very troublesome to blast, since the first shot frequently fails to "fetch" the bowlder, and instead thereof, brings down about 200 feet of bracing, and two-thirds of the street on each side.

It is in this neighborhood that tradition or superstition located gold mines, and there is a tale of a subterranean chamber filled with hidden wealth. A few years ago one misguided man had faith enough to make investigations, doubtless foreseeing the result of the late election, and wishing to obtain a supply of the yellow metal. He first started a well driller, and at a considerable depth the drill struck something much harder than the rock, and upon examination it was pronounced to be concrete or some kind of artificial stone. After passing through about 18 inches of this material, the drill suddenly sank down about 6 feet, showing that the treasure cave was reached. With his faith re-enforced, our man set to work to sink a shaft, but soon encountered water in large quantities. Nothing daunted, he procured two steam pumps and started to dry up the whole community. But the neighbors being very fond of water, and enraged by the failure of their wells, soon compelled the enthusiast to desist, and so to this day that mass of gold still lies deep down in that underground chamber, undisturbed by any political schemes. We have honey-combed that region with our sewers, but have never encountered that treasure. Gold and silver are most decidedly not the "obstacles which we have met and overcome in sewer construction."

LATERAL SEWERS.

H. W. M'DONALD, GALION.

The construction and maintenance of sewer systems in our cities and villages, has long been an acknowledged necessity, but, until within a few years, no provisions were made or thought necessary to operate and keep them in proper condition.

Experience, however, demonstrated the necessity of improvement and various methods were devised, prominent among which was reduction in size and arrangement for periodical flushing. These characteristics are now considered as among the essential considerations and introduced as circumstances will permit; but my object in submitting this paper is to get an expression from the Association, as to what constitutes a sewer system, and to what extent it is necessary to carry out the improvements referred to.

Acting upon the suggestion of our worthy Secretary, in relation to the treatment of subjects, I shall venture to relate a little experience of my own, trusting that, while it may not develop anything particularly new, it, possibly, may evoke something which will prove beneficial to the profession, as well as the general public.

Some years since I was called upon to prescribe for a "house drain" which the owner described as "in a terrible condition," and upon visiting the premises, I found that his description was not in the least overdrawn. He told me that the "drain" had been subject to periodical attacks of a like nature—that heretofore it had yielded to domestic treatment, but in this instance everything they tried had failed to afford relief. The fine lawn was perforated with holes reaching down to the "drain," six feet or more below the surface, in each of which the 6-inch sewer pipe had been punctured, in order to locate or determine the nature of the obstruction. Several shingle lath, nailed together, a long iron rod and various other seweretical instruments were scattered about the premises. Boards, boxes and barrels were floating around in the basement, and, upon asking the cause of such a phenomena, I was informed that the workmen, failing to relieve

the situation with instruments, had, as a last resort, advised the procurement of the hose company, who came—and had just left several hundred barrels of water in the basement! Although the premises were dotted with beds of flowers, in full bloom, the odor seemed to be entirely foreign to them, while the closing of windows and slamming of doors in the immediate vicinity seemed to indicate that even the ladies were opposed to "sanitary improvements."

I had had considerable experience in ditch and sewer work, had worried through swamps, rock, beds of quick sand, etc., but this was a poser, and yet I had been sent for to devise ways and means, and something must be done. After due examination and deliberation, I informed the owner that the only known remedy would be to commence at the outlet, open up the entire drain, carefully remove and clean out the pipe, and then relay it to proper line and grade; otherwise it would be necessary to construct a drain of entirely new material, which, under the circumstances, might be the most advisable. He couldn't think of going to the expense of purchasing new material, and instructed his workmen to proceed to dig up the old drain.

I cautioned them about breaking the flanges of the pipe, and told them it would be necessary to remove the old cement after the pipe was on the bank and properly cleaned out—that as soon as they had this done I would examine the grade, give them instructions about laying and cementing the pipe, and see what further work was necessary. I then left for my office, and Mr. Jones, my employer, for his place of business, hearing nothing from the work until Mr. Jones called upon me some days afterward and informed me that the workmen had abandoned the job, and that he could find no one to do the work. I mentioned several men who I thought were unemployed, and suggested that he see some of them. He replied that each of the parties named had seen the work, and some of them had even insulted him by saying that he had "better pull off his coat and do that class of work himself." He had made some very pointed remarks about the "shocking independence" displayed by laboring men, but added that his household, and the entire neighbor-

hood, were up in arms, and he supposed there was no other way but to dig a new drain, and wanted me to order the material, employ the necessary help and see that it was completed as soon as possible.

I had no difficulty in finding men who were willing to work, and on arriving at the premises found that the old trench had been opened up the entire length, down to the pipe, and that a few broken joints (which merit no particular description) were on the bank near the outlet.

For our own protection, the pipe on the bank were buried in the excavated earth, and the mouth of that in the trench closed with like material. This being done we measured up the line, sent for the necessary material, and, pending its arrival, proceeded to establish a parallel grade line, above the surface, and to excavate a grade on one side of the pipe in the old trench, which we found had originally been dug much wider than necessary.

As soon as the pipe was delivered we proceeded to make the connection at the main sewer, and to lay cement and tamp the pipe, measuring down from the line at every joint, and in a few hours had it in shape to turn on the water in the basement, but suspended operations in order that the cement in the joints might set sufficiently to stand the required pressure. On the following morning, before Mr. Jones had left for his place of business, we were on hand and invited him to witness the first flushing to which any "house drain" in the city had ever been subjected. To prevent the water from rushing in and interfering with the partially filled trench, and to confine it exclusively to the pipe, we made a barricade of matched boards, extending down about a foot below grade, tamping in earth solidly behind it. We then inserted a flanged section of 6-inch tin pipe through a hole of corresponding size in the barricade, and into the drain pipe, tacked the flange to the boards, and with an improvised screen set up in front of it, proceeded to tunnel under the foundation of the building. This being accomplished, one of the men (who had formerly been a sailor) secured a plank, and launching it in the basement, proceeded to locate our tunnel, and by a few well directed efforts with an iron bar, opened up communica-

tion with the sewer system. There was a general rush of the pent-up water, filling the trench nearly to the heighth of our barricade, while a miniature maelstrom was in operation in front of it. We all watched the receding water in the basement, none seeming more interested than Mr. Jones, and, after a lapse of some minutes, a peculiar whistling sound notified us that air, as well as water, was rushing into the pipe, when the water soon disappeared.

"Say," said Mr. Jones, "if I could have some such an arrangement as that to discharge water into my drain occasionally, I believe I could keep it as clean as a whistle. One thing is certain—this thing of having to be continually tinkering at and punching out a drain, digging up your lawn and disarranging things generally, to say nothing of the expense, the disagreeable, unhealthy and dangerous character of a neglected and sluggish drain, is more than I propose to endure, and unless something can be devised to materially improve present plans, I shall shut off my connections and return to primitive methods."

I replied that I thought him quite right in this decision, but what surprised me was that numbers of others, whose experience I knew to have been equally aggravating, had not arrived at the same conclusion. "Well," he said, "if you have any plan whereby you can prevent a repetition of this kind of experience, go ahead and carry it out." I told him, if he desired it, I would submit a plan which I was satisfied would do the work and prove entirely satisfactory. "Never mind submitting a plan," he said, "if you can do the work and it answers the purpose, I'll pay you for it, but if it don't you can charge it up to an experience account, as I have done. I shall invest nothing more in experiments." I told him I would take my chances, and commenced work immediately. The residence was supplied with all the modern improvements, including closets, bathroom, sinks, washstands and laundry, with pipes leading from them to the soil pipe, terminating in an iron trap connected with the "drain."

The first thing necessary was to remove the trap and clean out the soil pipe, which we found quite an undertaking, but finally succeeded, and substituting a "Y" branch for the trap,

connected it with the soil pipe and with the new line of "drains." The joints were then all properly caulked and the water turned on at the several connections, proving everything to be in running order. We then went outside, and at a point opposite the soil pipe and a few feet from the wall, made an excavation for a circular cistern, or tank, to hold, when complete, about 20 barrels of water. After getting down the proper depth, we tunneled under the wall and connected 6-inch sewer pipe with the "Y" branch in the basement, and extended it so that a 4x6 "T" would come to the outside, and an elbow to the center and level with the bottom of the tank.

After the joints were all properly cemented and earth thoroughly tamped around the pipe, the tank was walled to within eighteen inches of the surface with a 4-inch brick wall, laid in lime mortar, 4-inch inlet and outlet pipes having been walled in near the top and the latter connected with the drain as per plan. The bottom was then properly shaped, all rubbish and loose earth removed from around the pipe and a course of brick, well bedded in cement, laid in flat, the brass valve seat bedded in cement over the mouth of the elbow, and the whole grouted and given a heavy coat of cement, well troweled down over the brick and flange of the valve seat, leaving the surface smooth and converging to the center. The cover consisted of flagging, with an 18-inch hole wrought in the center, and rabbeted, into which was fitted a piece of sewer pipe, known as a "cistern top," the stone having been properly bedded on the wall, and all joints filled with cement.

Trenches were then cut and pipe laid to conduct cistern overflow and water from the yard hydrant into the tank, as shown, thus affording both a natural and artificial source of water supply.

The manhole lid in this case was made by nailing inch boards together at right angles, on which was screwed a small casting with slotted hole, for valve rod. The valve was then lowered to its seat, the lid adjusted over the rod, handle screwed on, and, after properly filling up the trenches and cleaning up the lawn, we pronounced our work complete.

In describing the reconstruction of the main line of drain, I omitted to mention a variation from the original plan, by substituting a 6-inch handhole trap for a "T" branch, under the corner of the stable and inserting a 6 to 12-inch increaser, which latter sized pipe was extended up to the floor, where it was increased to 15 inches, furnished with a double lid seat, and the water from the roof of the building conducted into the pipe as shown in "figure 3."

After the interior of the tank had dried sufficiently and been treated to an extra coat of "whitewash cement," we turned on the water at the yard hydrant, filling the tank to the overflow, just as Mr. Jones put in his appearance. We told him he was just in time, and requested him to notice the action of the water in the exterior water closet when the tank valve was raised. Everything in readiness, I raised and suspended the valve as shown in Figure 3, and proceeded to see how Mr. Jones was pleased with the exhibition.

He said the water came with a rush, raising two feet or more and swirling around in the vertical pipe as if it meant business, and if the tank and valve continued to work all right, he believed I had furnished exactly what he wanted. To satisfy him regarding the matter, I told him to lower the valve to its seat, refill the tank and let it stand until the following morning, when he could readily detect any leakage that might occur, and, that being interested in the matter myself, I would call and see that any possible defect was remedied and that the valve continued to perform its work.

The next morning found the water all there, and after repeating the flushing operation, Mr. Jones expressed himself as entirely satisfied with the work. This was some four years ago, and with the exception of supplying one extra gasket during that period, no farther expense has been incurred, and Mr. Jones takes pleasure in recommending the system, knowing that his private sewer is both in running order and excellent sanitary condition. The entire cost of the improvement, exclusive of the drain (which he had to have in any event) was $31.00.

This amount might have been considerably less and

answered every purpose, had we constructed a ten instead of a twenty barrel tank, but I knew that my employer would want it large enough, without a question, and governed myself accordingly.

Since constructing the system for Mr. Jones, I have had occasion to apply it, under varied circumstances, with equally good results, and three years ago introduced it into a little villa of our own, just outside the city limits. Not having the benefit of "city" we found that country water answered equally as good a purpose—the only difference being that we substituted pumps for yard hydrants, and had the water furnished free of charge.

Experience soon demonstrated that waste water from the pump, together with an occasional cistern overflow, kept up the necessary water supply, and the work proving satisfactory, it was gradually extended as new residences were erected, until we now have eleven tanks with an aggregate capacity of 150 barrels, which can be discharged at will, thoroughly flushing not only the "drains," but the entire length of the sewer with which they are connected.

The majority of residences in the villa are without regulation plumbing systems, and as the public sewers are located in alleys instead of streets, private sewers, as a rule, are constructed as shown in Figure 2, subject, of course, to such changes as required by the location of buildings and water supply, while all buildings, smaller than coal or wood houses, are conspicuous only by their absence.

Wherever residences are supplied with interior closets, sinks, etc., the tank is located beyond the soil pipe, as outlined in Figure 1, and shown in accompanying profile. But this article has already been extended to twice its intended length, and I shall close by again stating that the object is to get an expression as to what constitutes a sewer system. Whether it consists of the main or thoroughfare sewers, or whether the network of private sewers, or "house drains" comprise any part of the sewer system? Whether city or sanitary engineers, city officials or anybody else knows, ought to know, have a right to know, or should know how they are constructed, maintained and operated, and how

much any of us know about the private sewers or "house drains" of our respective cities? Whether a 6-inch sewer on private property, connected with a 12-inch sewer on public property, requires a proportionate amount of attention, or whether it is capable of taking care of itself without prejudicing the rights and interests of the general public, or endangering the lives of the owner and his family. Whether it would or would not be conducive to the public health, convenience and welfare to have all sewers, public and private, constructed under the supervision of our respective city engineers, whose duty should be to plat and keep an accurate record of the same; and, finally, if private sewers were so constructed, and received the requisite amount of flushing to keep them in proper sanitary condition, whether the flushing of public sewers could not be dispensed with and the public interests better subserved.

DISCUSSION.

Mr. Gilpatrick: I would like to ask what is the cost of a five-barrel flush tank?

Mr. McDonald: It would depend entirely upon the labor. The labor is the principal expense. A very fair estimate would be about 75 cents per barrel. A tank as small as five barrels would cost more in proportion than a ten barrel tank, on account of getting the material on the ground.

Mr. Gilpatrick: Do I understand that the cost of a twenty-barrel outfit was thirty dollars?

Mr. McDonald: I have had ten-barrel tanks constructed at a cost of 75 cents per barrel.

Mr. Cronley: What is the fall from the house to the sewer?

Mr. McDonald: That will have to be governed by what we can get.

Mr Cronley: I mean, in this instance?

Mr. McDonald: In this case there was very little fall; I think in 250 feet it was not over ten or twelve inches. But the height of the water in the tank really gives us the fall, that is the head.

Mr. Cronley: What is the height in that above the grade line?

Mr. McDonald: The water stands four feet high in the tank. Of course, that would force the water out of the tank on a practical level.

Mr. Cronley: Where is the tank located with reference to the closets?

Mr. McDonald: Just outside the building, always at the head of the private sewer.

Mr. Cronley: That method seems simple and effective.

REPORT OF COMMITTEE ON RAILROAD CONSTRUCTION AND MAINTENANCE OF WAY.

JOHN A. HANLON, CHAIRMAN, COSHOCTON.

Your committee begs leave to submit the following report: That, constituting as we believe we do, the first committee of your Society under this title, and finding no precedent as to the scope of a report upon this subject, we have assumed that within the time in which we may engage your attention, we may not more than give you a general outline of the situation in railroad construction and maintenance in the United States.

The most reliable authorities report that the mileage of railroad construction for 1896 was about the same as that of the previous year, 1,800 miles, of which in Ohio in 1896, only 63 miles were built, and in Pennsylvania about 90 miles.

The three states having the greatest mileage and considerably in excess of any other state, are California, Louisiana and Michigan. This refers to the mileage of track actually laid.

The mileage for Ohio for 1896 may be considered as the smallest of any single year since the 60s, during the war, when railroad construction was almost entirely suspended.

Nearly all the mileage reported in Ohio for 1896 was built by the Lima Northern Railway Company.

In western Pennsylvania is now being constructed what is known as the Butler and Pittsburg Railroad, to run from Butler to Pittsburg.

It is an extension of the Pittsburg, Shenango and Lake Erie Railroad from Conneaut, O., to Butler, Pa., Conneaut being the lake port.

This line is also known as the Carnegie road, after Andrew Carnegie, who is said to be the largest stockholder in this very expensive fifty miles of railway. When completed to Pittsburg, it is expected that this line will cut quite a figure among the iron ore carrying roads from the lakes to the Pittsburg iron district.

The work of grading and the iron and steel viaduct and bridge work on this line is especially heavy and expensive.

A feature of the specifications as to classification of material in excavation, or rather the non-classification of it, is somewhat out of the usual order in the construction of entirely new road-beds.

But one straight price is paid for all kinds of material, be it earth, hard pan, shale, loose or solid rock.

The advantages and disadvantages of this method of paying for excavation work is a proper subject for discussion, and like all other questions, has two sides to it.

The greatest work of railroad construction ever undertaken as a single line, is now in progress, the Trans-Siberian railway, 4,700 miles in length, and estimated to cost nearly three hundred millions of dollars. It will, of course, in time develop a vast section of country, almost in part unknown and uninhabited, but it is believed that not the least among the motives actuating the Russian Government in its construction, is its value as a war measure.

It is significant as to the standing of our American railways that the Russian minister of transportation, Prince Hilkoff, lately paid this country a visit, to so far as he could in the time allowed him, observe our methods of construction and conducting transportation. Locomotive plants and steel-making plants are being constructed in connection with the building of these Russian railways, largely under American management, and almost entirely will these plants be equipped with American made machinery. Contracts amounting to half a million dollars for machinery were placed in this country at one time during the past year.

Referring again to our own state, we may say that when we are relieved from the prevailing financial and industrial distress, and prosperity has reached all lines of business, we may anticipate large expenditures of money in new construction, both on new lines and in the improvements of existing lines, as double-tracking, revision of road beds to secure better alignment and grades, masonry, bridges and buildings.

Many of the grade crossings throughout our state have been equipped with interlocking appliances, which in new con-

struction, so far as practicable, should be made an indispensable part of every grade crossing.

Passing to the subject of Maintenance of Way, your committee need scarcely call your attention to the fact that the enforced reduction of operating expenses incident to the financial troubles of many of our railroads has brought about a situation in which it has been impossible to maintain the usual standard of condition in track, roadway, fences, drainage, buildings, etc.; but with few exceptions these lines may be said to be fairly within the limits as a safe means of transportation. The best result in maintenance of way is generally found where there is uniformity in manner and method of doing the work, and where there are standard plans for all structures from buildings to whistling posts.

The system inaugurated several years ago, we believe by the late C. C. Waite, of paying premiums to the supervisors and foremen on track work, has been productive of good results, and is now a fixed institution on many of our railroads. First, second and third premiums are generally paid, and the awards are made after the annual inspection of the line by the officials of both the maintenance of way and transportation departments, who are accompanied by all of the supervisors or road masters, and the section foremen of that division, who are enabled in this way to see what others have been doing elsewhere on the line.

While not strictly within the scope of this report, being a matter pertaining to the operating department of a railroad, we mention the introduction of electric motors or locomotives upon the tracks of steam railroads. This has been done in several places in the east on short lines to handle passenger traffic, and again in switching service in yards and at terminals. The press informs us that on one of the railroads entering Cincinnati, steps have been taken to equip a portion of the line for electric motive power.

It appears that the experimental stage has passed, so far as to the efficiency of electric locomotives under the conditions to which they are best adapted, which may be said to be those

of city and suburban and inter-urban lines for both freight and passenger traffic, docks, terminal yards and tunnels. A notable instance of the use of the electric locomotive is in the B. & O. R. R. Co's. Howard street tunnel, in the city of Baltimore. This tunnel is lengthwise and beneath Howard street for a distance of over 8000 feet and double-tracked, and on account of its length and difficulty in ventilating, steam and coal-burning locomotives would be impracticable.

Your committee has, so far in this Report, treated its subject in a somewhat rambling and disjointed manner, and without taking up some of the details of the subject (particularly under the head of Maintenance of Way) which, being properly handled, could be made both interesting and instructive.

A member of our Committee has suggested that more valuable results might be had by the Committee confining themselves to some particular point in practice, either in construction or maintenance of way.

This might be considered the prerogative of individual members rather than of the Committee, but be that as it may, your Committee expresses the hope that at our next meeting, either this Committee or some member of the Society will give us his views on "What constitutes a good and valid contract for right of way of either railroads, highways or streets, and what is a proper description of such right of way for a deed of conveyance?" and quoting decisions of the courts.

We believe that the information and discussion which such a paper would bring out would be of general interest to the members of the Society, and, coming under the head of contracts affecting real estate, would be of interest to Engineers in general practice as well as those in railroad construction and maintenance of way.

DISCUSSION.

Chairman Paul: There is one question of interest which Mr. Hanlon has raised in his paper, relating to the propriety of making a contract one general classification instead of dividing it up into various items of loose rock, solid rock, etc. I

would like to hear an expression of some engineer on that subject.

Mr. McKay: Mr. Chairman, while I followed railroad work that was the general practice, to classify on most work. I remember one little piece of work, however, on which there was no classification and it worked very well. When I first began this county work, we had some heavy work in the way of improving hills, and on one or two contracts I classified; but after that I made up my mind that it was not a good thing to classify in county work. Between the contractor and the county commissioners, it is hard for the engineer to do justice to both county and contractor. Since that I have done away with classification altogether and sell the work at a price per yard, and the contractor takes the chances on being informed on the work to be done. I believe as far as county work is concerned, it is the better way.

Mr. Hanlon: I will say that one of the best reasons for adopting this plan is that it removes a fruitful source of litigation from disputes as to classification between contractor and engineer in railroad work. Of course, it lessens the work of the engineer as well; but that does not cut much of a figure.

Chairman Paul: Does the question not resolve itself into two things—that the company must get its work for the lowest possible price; and second, that the contractor ought to get paid for all he does? And isn't is a question whether the engineer, in seeking to put a lump classification, or no classification in the contract, is not shirking a duty, whether it is a duty to a corporation or his clients? I am inclined to think that in many contracts there are no means of telling in advance what the material is, even by boring or explorations, but must be determined as the work goes on. That there are disputes and differences of opinion between the contractor and engineer may be true, but whether or not that had better be assumed in view of the benefits actually received, is another question.

Mr. Lewis: I do not believe either one of the methods proposed is the ideal solution of the question. The two ways of letting work might be compared, the one of letting the work

in lump classification to buying a pig absolutely in a poke, without a chance to heft the pig; and the other, to paying for it after killing and eating the pig and knowing just what it was made of. It is a dead horse, and hard to settle. I believe in taking some course between the two, where the buyer will have a chance to inspect the pig without acquiring final possession by eating it.

Chairman Paul: So far as classification is concerned, I think there should be classification, but it should be made at the time that the monthly estimates are made up; it should be much more conclusive than it usually is. I recall an experience in Pennsylvania where a long line of railroad was being constructed. The contractors were getting along nicely and were satisfied with the estimates. After the work was completed, the chief engineer came onto the work and re-classified it and in so doing reduced all the contractors, who had previously thought they were making money, to a state of bankruptcy. As suggested by Mr. Lewis, a large portion of the evidence had been destroyed. I think the error in that case, and in all such cases, is that the engineers do not pay sufficient attention and are not sufficiently bound by the progress estimates that they make out. I think they should be bound to a larger extent; that when the monthly estimate shows they have passed solid rock, there should be substantial reasons for withdrawing it, and proof should lie with the engineer and the company.

Mr. McKay: There is one plan which I saw tried, that I think a good one. The contractor bid on all different classifications, but when he strikes anything he considers outside of the regular classification, he notifies the engineer in writing before removing it. The matter is then determined before removal of material and there is never any misunderstanding.

Chairman Paul: And it is settled permanently at the end of the month?

Mr. McKay: Yes, sir. When it goes on the monthly estimate as loose or solid rock, it always remains just that way.

Chairman Paul: Not just that way, but the quantities should not be materially reduced.

Mr. McKay: Yes, sir; that is the point.

THE TOPOGRAPHER IN RAILWAY LOCATION.

J. A. HANLON, COSHOCTON.

Topography, in its application to engineering operations, consists in the delineation upon a map, of representations of surface areas, with all the lines and elevations of natural and artificial objects thereon to show either comparatively or with accuracy the positions, slopes and angles, as may be necessary for the purpose for which the mapping is intended.

For its use in railway location, both the field work and mapping must be carried out by methods which will locate the elevations at such points as will admit of the plotting of cross-sections and profiles over any portion of the work within a reasonable degree of accuracy.

Among the methods of representing the surface elevations is that of by contour lines, which is the only method of constructing a map upon which a line of railway location may be projected sufficiently accurate to reproduce upon the ground or from which to make estimates of quantities and cost; or for any purpose for which topographical maps may be used, those in contours are the only ones which can convey an intelligent idea of the true slopes and elevations.

"Hachure" work, colors or shades put on with the brush, can only show comparatively the angle of slopes, but not the degree, length or height of any part of them.

The organization and field work of the topographer's party having a very important bearing upon the value of results from the map, we may consider their work as really the most important part of the preliminary survey.

As an illustration of the methods to be employed in this work, we will assume that a location for a railroad is to be made upon a line, the general route of which has been previously determined, and that the next step is to project the location and make up the estimates of cost without necessarily running in the located line on the ground.

The general topography of the country may be considered as similar to that of Eastern and Southern Ohio.

In the organization of a separate party to assist the topographer, the length of the line or the time which will likely be required in making the survey will determine whether the topographer's work will follow immediately the transit and level parties, or whether later the party will be made from the other parties after the completion of their survey, with possibly the transitman or levelman in charge as topographer.

In the event that either the transitmán or levelman is put in charge, he loses his identity as such, and becomes a topographer, and in charge of the most important part of the preliminary survey, from which is to be developed the final location.

He may be a very good transitman or levelman, but a very poor topographer. The good topographer is supposed to have some ideas of location himself, to get full and complete notes of everything in sight, keep his books and notes in neat shape, and if something of draftsman himself, all the better, as he can probablv plot his work on the map in better order than anyone else.

It will be found to be economy to provide the topographer with three assistants.

The instrumental equipment should consist of a hand level, a prismatic compass, a seventy-five foot metallic tape line, a fifteen foot rod graduated to feet and tenths, and a five foot rod.

The hand level preferred is the Binocular Hand Level, manufactured and sold by the Gurleys, Troy, N. Y.

Its adjustments are similar to those of a field glass, and has a magnifying power of about two and a half times. The Locke level has very little magnifying power, if any.

Several years ago I had some correspondence with the Gurleys in regard to the introduction of stadia wires in the hand level.

My recollection of their reply is, that to put in stadia wires would very considerably increase the size, weight and cost, which might be found objectionable in a hand instrument on account of its limited use.

Not having taken up the matter since, I do not know whether any improvement has been made in this direction by these makers or others, but I feel that if it is at all practicable, stadia wires would add much to the value of the hand level for many purposes; if this can be done within reasonable limits as to cost.

To begin his work, the topographer will be provided with a field book in which is entered only the station numbers and plus stations, with their elevations, all running from bottom to top of page.

The station numbers should be entered on the left-hand margin of the left-hand page, and the elevations on the centre line of the page running up and down.

Field books for topographers are sold by most dealers in engineers supplies, ruled on all pages in squares of about one-fourth inch or about the usual spacing between lines, and with a red ink line up and down the center of each page.

The left hand page is to be used for the notes taken of elevations of the contours, as well as all other elevations noted.

Notes should be made of the high-water marks, road crossings, ledges of rock, coal seams, or anything which will have any bearing in determining the alignment or sub-grade line in projecting the location upon the map.

The elevations taken on the right of the line are entered in the book on the right of the station elevation, and the distance out from the center line is entered directly beneath it, and elevations and distances on the left in the same manner, always remembering to enter beneath the elevation of any contour or any other point, the total distance from the center line.

Ordinarily, ten foot contours will be sufficiently close to construct a map on a scale of 400 feet per inch, but intermediate elevations will frequently be necessary, which can be noted on the map in proper position.

At crossings of streams where masonry will be built, it would be well to take the contours to five feet in order that on a larger scale, plans for the masonry may be developed, and the flare and length of wing walls be laid out to correspond to the

natural surface, as far as practicable, without a wastage or shortage of masonry.

The topographer should not be required to perform other duties than keeping the notes and using the prismatic compass.

Select one of the assistants who may have had some experience in survey work to use the hand level; an active man to use the fifteen-foot rod and the forward end of the tape, the rear tapeman to take the distance on the tape and call it off to the topographer.

The elevations are taken and the measurements made as follows: Supposing that the elevation at the station on center line is 62.4 and the slopes to the left and lower side are being taken, the assistant with the hand level will stand on the center line with his hand level resting on his five-foot rod, and, as the rodman moves out at right angles to the line, will move him out until he gets a reading of 7.4, which will locate the contour on the elevation of 60. The measurement is noted at the same instant by the rear tapeman. The levelman then steps up to the point held by the rodman, who is sent ahead again until the reading on the rod is fifteen feet or the top of the rod, which locates the contour on the elevation of 50, measurements taken as before, and so on as far in that direction as is deemed necessary.

Working next in the opposite direction, or to the right from the line, the levelman will precede the rod and tapeman. The rodman holds his rod at the center, and the elevation there being 62.4, the levelman will move up the slope until he reads 12.6 on the rod, which will locate the contour at the elevation 70. With the rodman at this point, the levelman moves up the slope again until h[illegible] 15 on the rod, which locates contour 80.

The metallic line is preferr[illegible] work for the reason that it does not become snarled and kin[illegible]s readily as a steel tape, as the work requires a great deal of shortening and lengthening and it is hard service for anything but the most pliable tape.

Measurements to the nearest foot are sufficiently accurate

for the purpose of locating contours, even on a map of 100 feet per inch instead of 400 feet, five-tenths of a foot would be lost sight of, or in cross-sections plotted from the notes, parts of feet would not materially affect the result.

As to the width of the strip or belt of topography taken on either side of the center line in this manner, the topographer must judge from the surroundings and the instructions of his chief. It will assist the topographer in this respect to have a profile of the line with the sub-grade line located approximately.

The five-foot rod specified has no other use than to steady the hand level and to fix the H. I. at five feet from the surface.

After a day or so in practice, the five-foot rod may be dispensed with, thus freeing one of the hands of the levelman, and he will find that he will be able to steady the level without the use of the rod.

So far as the fixed height of five feet is concerned, the line of vision of the man of average height is so near five feet than an allowance, if necessary, can easily be made for it in the readings.

The topographer, after having crossed-sectioned, will return and fill in the topography by the location of streams, roads, bridges, buildings, property lines with the owners' names, so far as he may be able to get them. The measurements will be made with reference to the center line, as usual, and the notes entered on the right hand page of the field book.

The work on this page should be sketched in as near its proper shape as possible in order to verify the notes, if any of them should become defaced or illegible.

The topographer will in this part of his duties find the prismatic compass of great use in quickly and with sufficient accuracy, giving the angles of crossings of roads, streams, property lines, and for triangulating to inaccessible objects.

This is an instrument which might be in every engineer's outfit to his advantage. It is an excellent instrument for topographical work and with a degree of accuracy sufficient for many purposes in general practice.

The magnetic needle in the prismatic compass is attached to a circular card, all being pivoted on the center as the ordinary compass needle. The card is graduated on the outer edge from 0 to 360°.

The observation is taken through two slotted sights, one of which, the eye end, has a reflector attached which shows the figures on the graduated card on the line of sights at the same time the observation is made and the needle settled.

It will, as in the case of the hand level, require some practice to steady the compass in the hand in order to settle the needle sufficiently to read to the nearest degree.

The reading should be noted in the field book in the sketch in the proper position, as read from the instrument, as 15°, 130°, 248° or 270°.

These can be reduced to the usual expressions in magnetic courses at the office, if necessary, but it is not necessary for the purpose of plotting, as will be seen further along.

It will be understood and computed mentally that the reading 15° is the same as N. 15° E., 130° is S., 50° E., 248° is S., 68° W, etc.

In addition to the instrumental work so far described, the topographer should take full notes of the material to be excavated, so far as can be determined from the exposures; character of the rock, if any, and particularly if in the vicinity of the probable sub-grade line.

With the property lines heretofore mentioned, the topographer will note the land owners' names and P. O. addresses. He should be careful to ascertain the name of the owner in fee. John Smith may be the head of the family, yet Mary Smith, his wife, may be the owner in fee of the land and she is the party who will have to sign all contracts as principal.

Also as to life estates, minor heirs, leaseholds, etc., all of which will have to be reported through the engineer's office to the Right of Way Department.

The notes taken by the topographer's party may now be considered as having passed to the hands of the draftsman at the office.

The transit line is plotted to a scale of 400 feet to the inch, with the station numbers entered at the angles and at all numbers ending with 0. Then plot the contours, laying the scale across the line, and dotting the distances off as read from the notes, which, being cumulative from the center, will not necessitate the shifting of the scale to every contour line. Connect the contour points of the same elevation by lines as the plotting proceeds.

Figure the elevation of every fifth contour in place and this line should, in inking, be ruled heavier than the others, in order that the eye may readily follow a given contour line without confusing it with others.

Having plotted in the contours, the next step is to plot the notes from the right hand page of the field book.

Plotting the notes from the prismatic compass is very simple.

Use a 13 or 14-inch, transparent or cardboard protractor, full circle, graduated from 0 to 360°, which corresponds to the graduation on the prismatic compass.

Lay off from a N. and S. line with the zero point of the protractor to the N., the reading as taken from the prismatic compass, and proceed in this way, always laying off the bearings or readings from the N. and S. line.

Points which have been located by triangulation in the field will, in this way, get their correct position on the map.

All other measurements having been transferred to the map and the same completed by inking in the lines and figures, the work may be put into the hands of the Locating Engineer for the projection thereon of the location.

Having at hand a profile of the preliminary line, and having also approximated the sub-grade line thereon, he will proceed to fit a location upon the map, using to determine the curvature best fitting the contours a curve protractor, which need be nothing more than a series of curves of different radii plotted on transparent paper on the same scale as that of the map.

The location of the curves being determined, they may then be joined by tangents and the angles of the curves noted

on the map. These angles may be worked out accurately, assuming that the angles of the preliminary were measured closely, as some of the located tangents will likely lie on or parallel to the lines of the preliminary survey, which will afford a check in the angles included in the curves.

He will now be able to make up a new profile of the line by plotting the elevations of the stations as they appear, either on a contour line or between them, estimating their elevation from the distance by scale to the nearest contour line.

The process of projecting such a location or making a "paper location," as it is generally called, is a task in which the engineer should supplement his map work with a knowledge of the territory through which the line is to be built, which he will not be able to acquire from others so well as from a personal examination.

The engineer who undertakes to make paper location from the most carefully prepared topographical maps without any personal knowledge of the route will not make as good a location as the engineer who familiarizes himself with the line or route, and has the difficult points fixed in his mind when he begins the paper location.

One of the great advantages of topographical maps and the paper location is that estimates of quantities can be made up from the new profile and cross-sections, without any further field work.

Contracts can be made for the construction of the line from the paper location profile, and is frequently so done.

Estimates made in this way on two or more routes without the expense of running in the location line will determine the least expensive of the number.

The fact that many of our railways, apparently with fair alignment and grades, have not been located in the manner herein described, does not prove that better results could not have been secured by this method. The objection raised against this method by some is that it is expensive. This objection has no foundation, in fact, if the engineering is properly conducted.

For the reasons set forth, it is really the least expensive

up to the point of running in the final location; and with results to be appreciated further on, the topographical work will be found to have been worth many times its cost.

DISCUSSION.

Chairman Paul: I noticed in particular the order in which this survey was made. I see, of course, it must vary somewhat according to circumstances. I have thought it advantageous for the topographer to keep right along with the party, and in that case he often has the benefit of the notes of the leveler and transitman. Simply have the station marks and record, a statement of elevation and depression in terms of the center line only, and afterwards reduce it to contours. The advantage of this method is that you can survey during the day and plat it at night.

Mr. Hanlon: As I mentioned in my paper, the matter of following the leveling party with the topographer's party depends on the length of the line. In a survey of some length the topographer's party, if the country is broken, will not be able to keep up with the advance party. Of course, the notes of the leveler must be brought back to the topographer.

Mr. Brown: The hand level Mr. Hanlon has here is a good one, and the right idea of a hand level. But those of us who have an old-fashioned Locke level can get pretty near as good results. By taking a Locke level and closing up the far end of it with a piece of pasteboard so you can not look straight through, hold it to the eye and keep both eyes open, with one eye you will see the bubble and with the other the ground beyond, and by optical delusion you will see the bubble running up and down the hillside. I find that every one who has tried it can work two or three times faster than with the ordinary hand level. To those who have never tried it, it might be interesting to try it. It will require a little practice to see with both eyes, but in a half hour one ought to be able to do it without any trouble.

Mr. Hanlon: What Mr. Brown says is correct, only there is one feature of the binocular level which is an advantage.

That is, the magnifying power relieves the eyes much in reading figures on a rod. If you undertake to read the gradations on the rod at a distance of 150 feet or more, it is a strain on the eyes.

Chairman Paul: That is the disadvantage of the ordinary Locke level—it has no magnifying power. Another question comes up in this connection in regard to making preliminary surveys which, under the slight amount of railroad construction in the last few years, is likely to become a lost art. A good many engineers are beginning to make the survey essentially and almost altogether topographical, approximating the line as near as may be, and in that way the stadia is coming into use. Perhaps some of the members have had experience in running preliminary lines in that way.

Mr. Sherman: I was very much interested in Mr. Hanlon's paper. There is one point there that I did not quite understand. He said the topographer should take cross-section or elevation notes, then come back and get the topography. Would you recommend that procedure?

Mr. Hanlon: No, sir; not to go very far ahead, probably a half a dozen stations—whatever is convenient—but to keep altogether.

REPORT OF COMMITTEE ON HIGHWAY CONSTRUCTION AND MAINTENANCE.

J. B. WEDDELL, CHAIRMAN, MANSFIELD.

Mr. President:—

The improvement of highways within the last year, like everything else, has been influenced by the hard times. In the country, farmers have been compelled to forego nearly everything calling for the outlay of money. The low price of farm products has discouraged those who are fortunate enough to be clear of debt, and distressed those who are not. Many farms, during the last year, have been sold by the sheriff at a loss of sixty to eighty per cent. from their cost twenty years ago.

As a rule the general taxes are higher than last year. In many towns street improvements have been deferred until the next season, hoping for easier times and the employment of labor, now idle, to relieve the strain upon the many who, having the means to supply actual needs, have nothing more.

It is now, in such times as these, that the engineer has a chance to develop his resources.

If he is "up-to-date" in best practice, he will carefully consider each step taken in the preliminary preparation of his work, that every dollar may be saved, consistent with a substantial improvement.

While we have in our midst suffering and distress, yet the present strait has a wholesome side when it taxes the mental resources to evolve solutions for the needs of the hour.

But if the engineer is a "back number" and continues to build up his work—as the bird does her nest—each like the first, which was also copied from another—uses the same heavy foundation for light as for heavy traffic—fails to study the influences governing the life of his work and disregards the experience of others who may differ from his view, how can he be a blessing to the taxpayer in such times as these?

Note the changes today, from ten or even five years ago, in the building of asphalt work. Formerly it was believed that

nothing less than an eight-inch concrete base and two and a half to three inches of asphalt would do for any kind of work. Later it was found that a six-inch concrete bed would fill nearly all conditions—and today it has been proven that for residential or light traffic streets, a four-inch concrete base with two inches of asphalt, or a three-inch base with two and a half inches of asphalt, is quite sufficient.

The improvement of country highways with piking has usually contained an unwarranted cost for grading. Much heavy earthwork has been done, of which the only thing that can be said in its favor is that it looks well.

When we consider that a good team of horses, on a good surface, will easily move a load of two tons up a seven per cent. grade, and that the ordinary load hauled upon our country roads seldom exceeds one and one-half tons, it does seem that so far as grading is required that it may only, in many cases, consist of simply leveling off the road bed with the cutting of side ditches large and deep enough to ensure thorough drainage.

Many miles of pike could have been built to what has been already, with the money used on grades that would be a credit to many city streets.

I believe that members of the profession, with study and judgment, can lift the profession to an enforced public recognition by becoming acquainted with the best practice of the day everywhere and developing a work sound in quality and fair in price.

ROAD BUILDING IN CUYAHOGA COUNTY.

JAY F. BROWN, CLEVELAND.

The general movement for good roads, which was specially noticeable in 1890 and 1892 in nearly all the states of the Union, came up in this county, and a general meeting of citizens was called to consider the subject and devise ways and means for securing good roads for this section. At that meeting a draft of a bill was made which later was introduced in the General Assembly and, after some modifications, was passed March 31, 1892, and became a special road law for this county. The text of the bill may be found in the Ohio Session Laws, Vol. 89, page 199, and provides that a tax, five-tenths of a mill, be levied on each dollar valuation in the county and an additional tax of one mill on each dollar of valuation in territory outside of the City of Cleveland.

This enactment placed at the disposal of the county commissioners about $90,000 yearly for the purpose noted in the Special Road Law above noted.

How to expend this sum to the best advantage to the county became the immediate duty of the county commissioners and the writer was chosen as engineer to build three roads in the year 1893; that is, to make the plans and specifications and conduct the work. In order to more fully understand the nature of this work, a short description of the soil and topography of Cuyahoga county is necessary.

The part of the county next to Lake Erie is mostly an alluvial plain, with a deep, sandy soil, underlaid with quicksand and at a greater depth, blue clay. Back of this plain, southerly, a distance of from one to three miles, is a ridge of elevations generally from 100 to 300 feet above Lake Erie. The soil of this part is heavy clay, interspersed with boulders, large and small, from the glacial drift; the sub-soil of this section is sometimes hard pan, sometimes the black shale common to the Cleveland district, and sometimes is blue clay. To devise plans and specifications for road building under these varying

conditions is somewhat difficult, and requires skill and experience on the part of the engineer to avoid failure.

After many years of experience and observation during the construction of public and private works, I have come to the conclusion that the first requisite for the improvement of a road or street is the thorough and complete drainage of the sub-soil of the roadbed to a sufficient depth to insure a solid roadway and preclude the possibility of its settlement after the construction is completed; such settlements break the bond and destroy the usefulness of any pavement or Macadam road. This principle applies to city streets as well as to country roads, and the lack of drainage has, in my estimation, been a potent factor in breaking up and rendering useless many expensive pieces of work in constructing roadways and pavements. The questions which relate to the construction of public works have long been a subject of controversy, but now that certain facts have been brought out and ideas verified by actual experience on the ground, it is well to accept a few principles of road building as settled, and as the purpose of this article is to detail the actual work in this county and to gather from the results obtained an idea of the future course to be pursued in this class of work, I may be allowed to go into the details of construction more fully. In order to have a clear understanding of the manner of constructing these roads, I submit the following plan, which was adopted in building the road known as the "Wooster Pike." This road is a part of the old stage route between Cleveland and Wooster, in Wayne county, and is reached by following out Pearl street in the City of Cleveland, through the village of South Brooklyn to the second toll gate, four miles southwesterly from said village, where the four miles of road built in 1893 begins. The road consists of a heavy, clay soil and sub-soil, and extends through a flat section of country, the only chance for drainage being occasionally a cross ditch or water course which was improved by lowering and enlarging them for use as outlets.

The following is the form of cross-section adopted and used for this road:

Sectional View, of a General Plan of construction, for an improved County Road, &c.

The dimensions of this road are as follows:

Width of roadway, thirty-two feet; eight feet of brick and twenty-four feet of earth road. The specifications for building were carefully worded so as to secure good material and good work, and this piece of road was finished in the fall of 1893. The road stands today as it was left by the contractor, and has not needed any repairs; an occasional scraping of the earth road has been done, but that is all. No ruts appear in the spring, and within two days after the frost is out of the ground the road is dry and smooth.

The primary idea of the drains, as above noted, is to drain and keep permanently dry a depth of solid roadway not less than four feet deep. I am firmly convinced, after long observation, that a drain will not do good work when placed under the center of a roadway. If asked for my reasons, I would say that in my opinion the sub-soil of the roadway would never be dry because the water must soak under the roadway before it can reach the drain. By the arrangement of drains above noted, the water cannot enter the sub-soil of the roadway from the fields because the drains stop the water from coming in from either side. The heavy rush of storm water is carried away by the large ditches at the side of the roadway. I am strongly opposed to the use of shallow drains; they are worthless for carrying storm water and are not deep enough to drain the necessary depth of roadway for a solid foundation, which should not be less than four feet down. I think the arrangement of drains shown in the plan is the best that can be devised for country roads, and these drains, carefully laid, are in themselves a first-class improvement for any road and re-

duce the thickness of road metal to be applied later fully one-half. That is to say, that if four feet in depth of roadway be thoroughly drained and becomes solid, the depth of road metal may be decreased to say eight inches in depth, or perhaps less.

During the same year I had charge of the building of two roads, using for road metal the common, blast furnace cinders or slag. This was put on the sub-grade of the road, when prepared, in three layers six inches deep, each broken with hammers, and each course rolled to a solid mass with a heavy roller. The top was dressed with a course of one inch of cement gravel and compactly rolled. The same system of drainage was used, and the roads have stood the immense traffic over them without a break. I attribute the success of these roads to the thorough system of drains in use on them.

Since they were built the county commissioners have built some roads without the deep drains, and already those roads show signs of breaking up. It seems a pity that it should be so. Since building the roads in 1893, I have watched the building of expensive stone pavement in the City of Cleveland, with a heavy concrete foundation without any drainage of the sub-soil and the pavements have settled out of shape, become rough, and will in a short time become costly failures; and all because the men who had the work in charge could not be brought to realize the necessity of thoroughly draining the sub-soil of the roadway.

The same pavement laid on common sand ballast, on a sub-grade properly drained, would still be in first-class condition, without a doubt.

JEFFERSON COUNTY TURNPIKES.

SAM HUSTON, STEUBENVILLE.

Jefferson county is entirely within the coal measures. The surface rocks of its northern townships are the sandstones and arenaceous shales of the lower part of the barren measures. In the central and southern townships a considerable per cent. of the surface rocks are the clay shales of the upper part of the barren measures, and the limestone clays of the upper, productive measures, from the disintegration of which results the most obdurate and tenacious mud to be found anywhere. The sandy material of the northern townships does not produce such bad roads as the clayey material of the central and southern portion, and consequently those who use the roads there have not felt the absolute necessity for improvement as farther south, and have not yet constructed any turnpikes.

More than thirty years ago a few miles of plank road were laid in certain localities, but were soon abandoned. Later the proximity of the national turnpike led to the use of limestone for the surface of about eleven miles of one-mile assessment turnpikes in the southwest corner of the county, but from inferior limestone and methods of construction, these have been in a measure relaid. The first road improvement by the county commissioners was under authority of a special act of the legislature in 1886, the road being an old plank road grade from Steubenville to the county infirmary, two and one-third miles. Under an act passed February 28, 1890, seventy-eight miles of turnpikes were constructed during the years 1890-1894, in the five central townships. Under the stimulus of this example, seven additional one-mile assessment turnpikes were constructed in the southern townships, making in all about one hundred and thirty miles of free turnpikes in use. Of these nearly one hundred miles have been under my oversight as engineer, but are far from being according to my views of construction, for the reason that the taxpayers have not realized the ultimate economy of thorough work, and restrictions as to cost and construction

have been placed on every mile of work done, either by legislative act, voters, or those having authority in the several cases. Yet these roads have satisfied the people generally, and are well worth their cost. The satisfaction given is illustrated by comparing the votes cast in 1890 by Knox township on the question of construction, when Steubenville would have paid over one-half of the cost of the proposed turnpikes in that township; one hundred and ninety-seven voting for and four hundred and sixty-one against the tax, and last year the question of building a system in that township without help from Steubenville, the vote for turnpikes was five hundred and sixty, and against turnpikes one hundred and fifty.

The surface metal used has been the coal measure limestones, in fact these are the only available material for the purpose, although they lack hardness to class them as the best grade of metal. Our experience has proved that they cannot be economically used of smaller dimensions than to pass through a two and one-half inch ring, in fact near Steubenville and other places, where traffic is heavy, it is found best not to be too rigid in requiring the stone to pass such a ring for repair. The amount of metal used has been in almost every case insufficient for good and durable roads, the minimum amount used being six inches deep and nine feet wide, and the maximum, with the exception of about six miles near Steubenville, ten feet wide and twelve inches deep. One-third of a mile built in 1886, on a road with rather heavy travel, with metal twelve inches deep and sixteen feet wide, has had very little repair, whilst other roads having no more travel and in use only three to five years have had heavy repairs. My experience has been that not less than twelve inches deep and twelve feet wide should be used, and from fourteen to sixteen feet wide where travel is heavy.

Open ditches have in most cases been depended on for drainage; four-inch sewer pipes were used on the worst part of the road, built in 1886, placed under the center of the metal; this, with open ditches, has proved the most effective method of drainage.

The rugged nature of the country near the Ohio river and

the general uneven character of the surface bring the question of grades very prominently to the front in the construction of our roads. The restriction as to cost of construction forced the commissioners in a few roads to adopt a maximum grade of twelve and one-quarter per cent. On nearly all the roads the maximum grade adopted was eight and three-quarter per cent., and on a few five per cent. Experience proves that the first is too heavy a grade for the maintenance of a permanent and satisfactory turnpike. The second about the best that can be secured in the hilly parts of the state, without the expenditure of more money than is practicable to obtain by direct taxation. The five per cent. maximum is very desirable where it can be secured.

The cost of construction of our roads has varied from $2,120 to over $8,000 per mile, including cost of grading. This large variation is due to three causes: Reduction in cost of material and labor, amount of grading required and accessibility of limestone. The latter especially will be shown by stating that repairs in 1896 were contracted for at from ninety-five cents to one dollar and seventy-eight cents per cubic yard. The highest price paid on construction for limestone in finished road was two dollars and sixty cents, and the lowest eighty cents per cubic yard.

Not to lengthen this paper too greatly I will say that my experience has led me to the following conclusions as to the proper construction of turnpikes in our county. A maximum grade of eight and three-quarter per cent. Grading completed at least one year previous to placing of metal thereon. Drainage secured by large open drains at each side of road, and use of tile in boggy or springy ground. Metal to be not less than twelve inches deep, nor less than twelve feet wide and up to sixteen feet in proportion to travel and weight of loads. Where practicable an eight or ten-foot clay summer road at one side of the metal and two or three feet of clay wing at the other side. Use of limestone broken by hand to pass a three-inch ring for bottom six inches, and two and a half inch ring for top six inches of metal. Thorough compaction of the material by repeated covering of the surface of each layer by a roller of from one to two tons for each foot of its tread. A crown to the finished road of six inches in a road twenty to twenty-four feet wide.

DISCUSSION.

In answer to a question Mr. Huston said: The lowest price we have lately paid for excavation for solid rock is nineteen and a half cents—from that to fifty. I will say in regard to the nineteen and a half cents, it was only for a short road. An old farmer thought the contractors were making money pretty fast and thought he would take a hand. He took a hand, but no more contracts for him since.

Chairman Paul: Is the limestone hauled far?

Mr. Huston: It is hauled from immediately at the side of the road to as much as three miles.

Chairman Paul: Why do you specify that the limestone shall be broken by hand?

Mr. Huston: That, I suppose, will bring on a long discussion. I will just state that my experience has taught me, from watching a hundred miles of road, that cubical blocks broken by hand keep in better repair and make a more solid roadbed than the flat pieces from a crusher.

A Member: What kind of a crusher have you used?

Mr. Huston: I have used several. I find there is no difference.

Mr. Gilpatrick: We find trouble in keeping the roadbeds smooth. The commissioners do not keep them in repair. We have also tried to have the wide tire adopted in our county, but have found it almost impossible to get anything used but the narrow tire.

Mr. McKay: Does your limestone run naturally in quite thin layers?

Mr. Huston: Some of it does.

Mr. McKay: Two or three inches thick?

Mr. Huston: No; we have little of that kind. We have a few strata of limestone in the south end of the county which takes that characteristic, but it is generally bulky, from two to three feet thick.

Mr. McKay: Do you suppose if it was crushed good and fine it would do away with the flat rock and rocking in the roadbed?

Mr. Huston: If you do that it grinds up and makes mud out of it.

Mr. McKay: We have limestone that is so hard, we crush it fine and it takes two or three years to wear down to make a smooth roadway. They wear smooth and rounding.

Mr. Kinnear: I would like to ask if, after the contractor made the rock excavation at nineteen and a half cents, he is anxious for another?

Mr. Huston: Not much.

A Member: I would like to ask why you do not take into account the sandstone or bedstone you speak of?

Mr. Huston: Just from the experience I have had in eleven years. It is of very little account, has no cementing quality, is too soft and will not bear the travel. It does not bind on narrow roads while it cuts the gutter right along. That is the trouble with the narrow roads. I use my utmost endeavor to see that no nine-foot road shall be built. The wheel follows the exact line all the time and is very detrimental to the road; while if we have a twelve-foot roadway it allows a change and keeps it in better condition. With a sixteen-foot road we have had very little repair put on and the first road we tried that way has been used eleven summers.

Mr. McKay: I want to ask for your opinion. Do you not believe it would pay to pay more attention to such roads as have been described, the first year they are built—if you put a man on to take care of it properly until it becomes solid, especially where you do not use a steam roller?

Mr. Strawn: I think the American republic might learn a great deal from study of the practice in some European countries. The English practice in building macadam roads is for the first year to place one man to each mile of road, and he has the care of that mile and nothing else; he has little piles of limestone to go to, to keep the road in perfect shape. The second year he is given two miles and is continued for some time on two miles, which he has under his care and he does nothing else. It is an interesting fact that the roads in England and some in France, which have been cared for in that way, have shown a nice even

surface for a long series of years. In regard to narrow roads, it depends much on what they are made of. There are narrow roads in existence now, old Roman roads, in splendid repair, but they were not built as we build our roads in Ohio. They are built of stone fitted like cameos.

A Member: The question of expense did not come in at all.

Mr. Strawn: I did not make the estimates.

Mr. Cronley: I disagree a little with the statements made. I do not think the people of the United States need to copy after any nation on earth. Take the county of Union, in the State of New Jersey, they have the best public roads of any place on earth. I believe some American roads, built with American skill and workmanship, are superior to any other roads in the world. The great trouble is they are afraid of spending money. It is not because we do not know how to construct roads, but the law does not give the means whereby we can construct them. We have three county commissioners to deal with, a detriment and in some instances almost a nuisance to society—it can go in print for all I care. I have had some experience with commissioners and I know what a drawback they are. I am in favor of laws that shall specify what an engineer shall do and then let the commissioners keep their hands off. I am willing to attend to my duties if they will attend to theirs, and until something of that kind is done we will never have good roads. I do not believe in building anything else than 15-foot roads, and 20 foot is better. In our roads the 10-foot is rutty all the time and it costs more to repair them. Now, if we constructed two or three miles in one year, instead of a half or a quarter mile here and there, and a few rods somewhere else, we would have better roads. The county commissioners make the levy each fall for road purposes and each township has a certain amount of money for roads. They decide to put in 20 rods here, 80 rods there and 100 rods somewhere else. There is always political influence; the man who has the biggest pile gets a piece of pike before his door. We have been doing that for 26 years in our county. There is no engineer's grade established, the supervisor and citizens volunteer to go out and make their own grade and the commissioners order

the pike put on there. This saves the expense of grading the road, and Allen county is one of the few counties which does not owe a dollar.

Mr. Strawn: I have been wondering whether it would not be a capital idea for the engineers of Allen county to commence to do missionary work. Rather than have the pikes without grades, why not donate their time and get good roads started? We must remember that we cannot ignore the county commissioner; he goes into office expecting that people give him credit for knowing how to manage millions of dollars, where he has not been able to manage his private accounts. But by showing what effect a good grade and construction and proper maintenance means, you might set an example which the county commissioners would not dare to ignore. There have been such things done.

In regard to the United States having the best roads in the world, I have not been all over and I cannot speak; but I think it is wise to see what is done by all countries as to economy and durability and try to select the best. Our road system is conspicuous as being the worst in the whole world. That is the verdict of intelligent travellers. The United States can turn out the largest per cent. of bad and indifferent roads. There are many reasons for this. We can only obtain better roads by adopting some system for getting better foundations, and this must come through the engineer. If the commissioners will not employ the engineer, only to measure up and see what is done, the engineer must set the example.

Mr. Gilpatrick: I wish to ask how Mr. Huston proceeds to smooth the surface when it becomes rutty? With the grader?

Mr. Huston: No, sir; that is a mistake. When one of our narrow roads becomes rutted it, of course, raises a little at the side. I find the best way is to put new material there instead of scraping it down.

Mr. Gilpatrick: After you put on new material, do you run over that with the roller?

Mr. Huston: Not where we only put on a light repair.

Mr. Gilpatrick: Do you not think it would be an advantage?

Mr. Huston: Yes, sir; I wish we could use it. It would certainly be a great advantage to use a roller, but we have never been able to use that in our county.

Mr. McKay: In our county the commissioners, for the past two or three years, have been trying to build a piece of road in every township on some good principle, so the people could see what it is and find what a good thing it is, and this makes a demand for more of that kind of work. In several townships in our county we have built from a quarter to a third of a mile, taking the worst piece of road we could find, shaping it up and putting it in good condition either with broken stone or gravel.

Chairman Paul: There is one point made in Mr. Huston's paper and that is as to the relative cost of hand-broken stone and machine-broken stone. I would like to inquire that of him.

Mr. Huston: That is a little hard to get at. My experience has been that there is very little difference. I have constructed roads under both specifications and the variation in price in the different localities and different years makes it hard to get at the difference, but it is very little. The items of transportation and quarrying make the greatest cost.

Chairman Paul: I will ask another question in regard to the hardness of the limestone. I know in certain parts of the state the limestone, when being quarried and broken, is too soft for road purposes, but on being exposed to the weather it becomes covered with a hard skin, or surface, so that it is sufficient for the purpose.

Mr. Huston: If Mr. Paul will go out to some of the quarries, they will give him a pointer as to the hardness and difficulty of breaking a good deal of our limestone. We can scarcely break it at all when it is exposed to the air a short time, but I am afraid it would take too long waiting to form a crust on some of our limestone, it crusts so slowly.

Chairman Paul: Would it crust in a year?

Mr. Huston: No, sir.

ELYRIA STREET PAVEMENTS.

C. H. SNOW, ELYRIA.

Elyria is the county seat of Lorain county, and is about 25 miles west of Cleveland. It had a population in 1890 of 5,500, but the location of the Johnson steel plant at Lorain has stimulated her growth so that she now has between 9,000 and 10,000.

When the writer was first appointed city engineer of Elyria, about ten years ago, there were about 5,500 square yards of small block stone pavement, 900 square yards of large flagstone pavement 16 feet wide, occupying the center of the street, and 900 square yards of the same extending from gutter to gutter, the flagstone being laid diagonally to the street line. The last pavements are still in use.

The first pavement I was called upon to provide plans for was on the finest street in the whole city. A street 99 feet wide, curbed so as to leave a roadway only 30 feet wide, the front fences nearly all removed, lawns well kept, and appearing like a well-kept park. The residents are for the most part wealthy and have large frontages. The pavement used and desired was a strip of heavy sandstone flagging laid in the center of the street 8 feet wide, with the balance of the 30 feet roadway macadamized also with sandstone, the whole to cost not to exceed $10.00 per rod of frontage, the village paying one-third.

The specifications for the flagging were: "The flagging must be not less than eight feet long, less than three feet wide nor less than eight inches thick." This sort of pavement, minus the part macadamized, was laid upon three other prominent streets, and nearly all of it is being used today. Some of our would-be witty people facetiously dub it the "sidewalk." It is a make-shift, but is, nevertheless, better than mud and deep ruts.

In the winter of 1891 our council thought it necessary to pave the unpaved part of the business street of the city in a better and more substantial way than any done heretofore; accordingly specifications were prepared for about 1,480 feet in Broad street, 42 feet wide, and 770 feet in Bridge street, 33 feet wide. They

encountered much opposition, and upon investigation some flaw was found in the proceedings and the whole scheme went overboard. The next year, however, the first brick pavement was constructed. The contractors did their best and the people saw the first good pavement in Elyria. We now have very nearly two miles paved with brick.

In the winter and spring of 1895 the Barber Asphalt Company's agent visited us, and succeeded in inducing the city council to prepare plans and specifications for asphalt side by side with the brick pavements, so that they might bid upon all pavements projected that year. They bid on five streets and succeeded in securing a contract for one street about 720 feet long and 40 feet wide. This is the history of the Elyria street pavements. The writer hereof has prepared the plans and specifications and the entire work has been done under the immediate supervision of the same for nearly all the pavements now being used in the city. Allow me to say here, with pardonable pride, that visitors and commercial men have said that no finer brick paved streets can be found anywhere than are found in our fair city. I might include in my list of pavements four other streets which are improved by macadamizing.

If I were called upon to give advice concerning the several varieties of pavement used, I should say of the flagstone strip pavement, don't, and of the macadam it is only a little better, but is admissable on streets having but little travel where the valuation is so low that no better pavement can be constructed. We have two, which have a wearing surface of furnace slag, and the other two have a wearing surface of limestone, some of which answer the purpose fairlv well.

The soil on which our pavements are constructed is for the most part a clay, varving from the stiff almost impervious, to that which is almost a loam, and it all makes a good sub-bed as long as it is dry, but when it is wet it becomes a veritable mortar bed. In excavation I impress the contractor with the necessity of making the sub-bed conform exactly to the grade and crown. Right here let me say that "eternal vigilance is the price" of a good pavement every time. We have always used a foundation

composed of broken stone eight inches in depth for our brick pavements, although other small towns near have used a concrete base, and their engineers have expressed themselves as afraid of it, yet our city council and public generally seem well satisfied so far with the broken stone base. The broken stone is put into the street in two courses, and each course covered with an inch of sand and then rolled. Sandstone is the material used, because of its cheapness (it can be had for the hauling). Such a foundation seems all right, where either the tar or grout filler is used, thereby rendering the pavement water tight. On every brick-paved street a tile drain has been laid next to each curb and the trench filled with broken stone in order to catch and carry away the water coming through the curb joints and under the same. I require a sand cushion two inches in depth in which to lay the brick, and which is rolled with a hand roller. A scraper cut to the true curvature and reaching half across the roadway is used to smooth the sand. Much care should be used to so prepare the sand bed that all parts are uniformly solid, and that, when the brick are laid and the roller placed thereon, there shall be no depressed places. In grading I have always driven the stakes about one-half inch high, to allow for rolling the brick.

The specifications regarding brick are the most important, and at the same time very difficult to compose, so that everything can be excluded that is not wanted. I have copied my specifications verbatim into this paper, not because I regard them models, but with the hope that the members here may make some suggestions which can be used in the future.

"Paving brick must be hard, well, uniformly and thoroughly burned, free from warps and cracks, and with the sides, ends and edges at right angles to each other. No soft brick will be allowed, and when specimens are broken they shall show a uniform homogeneous section. They shall be in every respect what is known as first-class paving brick. Bidders should bid on both the plain and lug brick, but shall hold the city harmless from all claims of royalty on any kinds or forms of brick used by them in the work.

"Paving brick shall be not more than ten inches in length

nor less than two and one-half inches in width, nor less than four inches in depth, but shall be as nearly as possible of a uniform size. Bidders will be required to furnish four brick as samples of the brick they propose to use, and such brick must be labeled with the name of the bidder and the name of the maker. The brick shall be culled by the contractor under the direction of the engineer, and all brick thus excluded shall not be used."

The greatest strain on an engineer's moral nerve comes when it becomes necessary to select the brick which are to be used. There may be from four to ten manufacturers represented with brick, ranging about the same in price, and each striving to obtain a "pull" on the engineer or councilmen, and some of them not above offering a little "filthy lucre" for a real or supposed advantage. I have found more difference in the quality of brick coming from the same yard when being used than in the specimens exhibited as samples from perhaps a dozen different yards. The samples are not generally taken out of the common pile with the eyes shut. We have used brick from seven different manufacturers, in the course of paving our streets. Of course I have formed an opinion as to which I consider the best of the seven kinds used. The Canton end cut block, I think, will prove to be the most durable. It is a large block, coming from the die or mud machine endwise, thus making the section smaller, which fact would have a tendency to give it a more uniform texture. The corners can also be rounded without the added expense of a repressing. These brick are laid in a street in which there is a street railway, consequently the entire traffic is concentrated along about the same lines, thus wearing much faster than would be the case if it were spread over more surface. This pavement was constructed two years ago, but it shows no appreciable wear. As to the choice of brick, the engineer should remember that the ideal paving brick is as hard and as tough as the best trap rock, and should be as impervious to water.

In the beginning of my work of this kind, I was prejudiced very much in favor of fire clay brick, but after using some good brands of the shale, I am inclined to believe them to be the most durable. They absorb scarcely any water, are very hard, but are

perhaps not quite so tough as the fire clay. In laying the brick to be filled with grout or tar, I require the brick to be driven together only sufficiently to keep the rows straight.

The brick have been usually culled during and after the laying. Soft brick in some cases have been difficult to detect, but I found that after a rain any child could pick them out, as they absorbed so much water as to require three or four hours before becoming dry. I think a brick which absorbs so much water during a summer shower that it will not dry in an hour or two of sunshine, should not be laid in any pavement. After the brick are laid we require the pavement to be rolled till the engineer is satisfied, which means that the contractor must roll until the roller seems to have no effect. I have kept the roller going until every part had been rolled a dozen or more times. At the same time, if the roller reveals any depressions, that part of the pavement is taken up, more sand used, the pavement is again laid and rolled again. I prefer rolling to tamping, for I think it gives a smoother and more even pavement.

All of our brick pavements are "filled" either with tar or grout. The tar makes a very good "filler" if the material is good and if it is applied hot enough when the pavement is dry and the weather is warm. It is objectionable from the fact that it ought not to be applied only in warm and dry weather, and is very slippery until the sand and dirt becomes worked into it.

The grout "filler" used has been the "Murphy" grout and Portland cement grout. The agents of the patentee of the "Murphy" grout mixed and applied all the grout of that kind used, and their work here is entirely satisfactory, with the exception of a part of one street, which was done in freezing weather, and some of it became frosted before being set. The Portland cement grout was mixed and applied by the local contractor, the mixture being equal parts of sand and cement. I require the contractor to keep the street closed five days after the grout is applied before opening it to traffic. The heat of summer has caused our grout-filled pavements to expand, which expansion has lifted them from the bed.

Concerning the asphalt pavement, I can say but little. Our

pavement was constructed by the Barber Asphalt Company, and seemed to be made upon honor. We have a five-year guarantee, secured by the retention of ten per cent. of the cost. It is now passing its second winter. It consists of a concrete foundation three inches in depth, composed of one part best Rosendale or other good cement, to two parts clean sharp sand, thoroughly mixed dry, and then made into mortar with the least possible amount of water; and this mortar is then mixed with broken stone, drenched with water, so that when thoroughly mixed and rammed, surplus mortar appears. The depth of concrete appears too little, but the facts are that when the concrete was well set, the contractors hauled their heavy loads of asphalt mixture on wagons with narrow wheels on this foundation and left no mark. An inch in depth of what is termed the binder course, composed of clean broken stone and asphalt, mixed hot, was next spread on while still hot and rolled until cooled. Upon this is spread the wearing surface one and one-half inches in depth. I am watching this pavement with much interest, for it is decidedly the most agreeable pavement we have. The cost, it seems to me, might be made more nearly that of brick and still leave quite a margin of profit to the contractors. The wearing surface one and one-half inches in depth is composed of about 75 per cent. sand, 12 per cent. pulverized limestone and 13 per cent. pure asphalt.

Herewith I give the cost of the brick pavements and the year constructed; this cost includes the curbing:

East Broad street, 1892, per square yard, $2.17; Grace Court and Second street, 1892, per square yard, $1.91; East Broad street, 1893, per square yard, $1.52; East Bridge street, 1893, per square yard, $1.59; West Broad street, 1894 per square yard, $1.08; Lodi street, 1894 and 1895, per square yard, $1.46; Mill street, 1895, per square yard, $1.23; West avenue, 1895, per square yard, $1.24; Court street, 1895, per square yard, $1.22; Third street, 1895, per square yard, $1.25; Middle avenue, 1895, asphalt, per square yard, $2.38.

DISCUSSION.

Mr. Strawn: Did the asphalt include any grading?

Mr. Snow: Yes, sir; it included the entire fixing of the street, grading, setting of curb, foundation and the street itself.

Mr. Strawn: What is the curb?

Mr. Snow: A foot through; the lowest bid was 21 cents. I will say here that the curbing for our streets is gotten in the quarry right in the city there, and is so much cheaper than where it has to be shipped. In depth it is 22 inches, mostly 24 inches. On Broad street we did put in 30 inches and 4 to 6 inches thick. Under these contracts most of it is 24 inches.

Mr. Strawn: Have you any data by which to get at what the asphalt proper would cost, on a prepared foundation, independent of the curb or anything excepting the top surfacing? The sub-foundation is all prepared.

Mr. Snow: I do not know that I can tell you now, but I can give you the bid which I think I have in my account book.

Chairman Paul: I understand what Mr. Strawn wants is what it would cost to take an old stone or brick pavement, which has a rough surface, using that as a foundation and on top of it put a dressing of asphalt.

Mr. Strawn: The street on which I live is now served with a macadam road-bed about 24 feet wide, and some of us are looking forward to a better street pavement. A few of us are very anxious, if posible, to see an asphalt pavement put down and the road-bed seems to be quite sufficient for the purpose. There will be no objection to raising the road-bed enough more by widening to maintain the foundation, as we have it intact. What would it cost to surface the foundation, which is sufficient, except what is necessary to receive the asphalt?

Mr. Snow: I have a bid here, Mr. Strawn, of an asphalt pavement, itemized as follows: Each square foot laid as required with Trinidad asphalt, including rolling, 19.6 cents, about $1.76 a square yard.

Mr. Cronley: We have what is called West Spring street, 6,000 feet in length, where we have contracted for putting on

asphalt. It was macadamized five years ago, and is in good condition. The citizens of that street petitioned the city council to have it paved with Trinidad asphalt placed on top of that macadam foundation, but after a great deal of inquiry from engineers and contractors, they concluded it would be bad policy to re-surface on the old foundation, so they got a new set of specifications requiring six-inch concrete. The American Standard Asphalt Company bid on a six-inch concrete foundation, one-inch binder course and a half-inch surface material, $1.74 per square yard, with five years guarantee. The asphalt is what they call the Wasach, from Utah. They laid 160,000 yards in Chicago and 100,000 yards in Minneapolis and in other places. The Barber Asphalt Company bid on a six-inch concrete foundation, inch binder, inch and half surface, $2.12 per square yard, and 4"x20" curbing one cent a foot. That included excavation, taking up the old macadam and grading it.

Mr. Strawn: Was the material in the old roadbed utilized in the roadbed for the asphalt?

Mr. Cronley: No, sir; it was not to be used. The city claimed that. It was too badly mixed with clay to be used. There were two other bids, but they were higher.

Mr. Strawn: I would like to ask of those who have had experience in contracting for asphalt roads, with a well-prepared foundation of broken stone that was put in at the time with a surfacing of gravel, making in the center 18 inches, and 14 inches at the sides, with under-drain on both sides, where the minimum grade would be, say 1.7 feet to the 100, with a fair opportunity of putting on a surfacing sufficient to receive the asphalt, whether it would be necessary to remove the foundation now in use?

Chairman Paul: I think the asphalt people are very particular about their foundations. That is one of the elements of their success; in the care and thoroughness with which it is prepared, and unless the foundation would be of an extraordinary and unusual character, they would be very loath to use it. If it was granite block or paving brick it would be all right, but anything outside of that, I take it, would not do.

Mr. Gates: There is Mr. Kinnear, of Columbus, who is

not saying anything. I think we have a case on Cleveland avenue which fits Mr. Strawn.

Mr. Kinnear: In Columbus we have tried almost every manner of pavement possible and still we know very little about it yet; but referring to the particular matter spoken of regarding foundation, my experience is that the best asphalt pavements that we have today have been constructed on old boulder pavements. In some cases we have had to adjust the boulders a little. Where we did we took pains to clean the boulders and ram them in thoroughly and solidly. On that we put an inch and a half or two inches of asphalt. We have many pavements made of asphalt on broken stone and six inches concrete; we have some of four inches. All our concrete foundations less than six inches have failed more or less. We have found places actually broken when the roller passed over. It is not satisfactory. In every case the old boulder pavements make the best foundation.

Mr. Snow: What is your soil?

Mr. Kinnear: Both gravel and sand—in the eastern part of the city there is clay; in the western part sand and gravel. In all cases I advocate sub-drainage. I think it is the most essential part of the work. In fact, it is all important to keep the street dry. In regard to putting asphalt on a macadam road, unless you put in a good size tile, three or four inches in diameter, and not much less than that, and the road has been traveled over a good many years so it has been well compacted, I would be afraid to put on asphalt. With proper drainage, good longitudinal and side drainage, that work would be successful.

Mr. Strawn: There was an interesting question raised in the paper in regard to the expanding of paving material and raising of that crossing. I will ask Mr. Snow if he has a theory or any facts explaining that?

Mr. Snow: In driving over that same street in many places it would have a hollow sound as though the pavement had raised from the bed, and other streets in the same way. It is hollow at the crossings and little rough, but none so great as that. My theory of the matter is that the pavement itself is a solid mass from one end to the other and has no chance to give a particle.

Consequently, the heating of the brick, which must necessarily expand a trifle, will cause the pavement to give, if it has any chance. In this case it was the center of the street and right on the turn of the grade, the grade running both ways, where the cross walk was, and, of course, it had a chance to lift it and give it that relief.

Mr. Kinnear: I would like to say a word on that subject. I had a little puzzling experience over the same thing. We built several streets of brick block, first-class foundation of broken stone, rolled, brick selected with care, put down with Murphy grout, but universally they have that rumbling sound. I have come to the conclusion that one trouble is that the foundation settles away from the surface. The bricks are put in in a curve, and once it breaks it will stand and the foundation sink away from it. In many places I have found it away at least an inch. In regard to this raising up, I had a little experience where a man was repairing a street. He heard an explosion and found the street had bursted up at a certain place. That was always a query, how that explosion occurred. It has occurred twice in our city here to the knowledge of our street inspector.

Mr. Snow: I would like to say in regard to the point of the foundation settling away that our street I was speaking about was laid across a bridge, a newly constructed arch, and the fill settled a little, though much pains was taken, breaking the water pipe and, of course, flooding the bridge. The foundation went down, leaving the pipe a foot under the pavement, leaving a space a foot in depth under the pavement and at least 7 or 8 feet across; but still the brick carried the loads across, and it was some days before we knew there was trouble.

Mr. Judson: Most of our brick pavements in Sandusky have been made with grout, nearly all Murphy grout. We had some trouble with the roaring noise, but found, upon investigation, that the only places where that occurs have been where the pavement was put down in cold weather, almost freezing; and where the pavement was laid in other time of year, when the weather was warm, there was no difficulty.

Mr. Strawn: Mr. Judson left that just half way told, like a novel which fails to satisfy our curiosity. Was it due to the fact that the material when cold was at its least dimension, and in warm weather expanded?

Mr. Judson: I supposed you would infer that.

Mr. Kinnear: The pavements I speak of were put down in warm, dry weather.

Mr. Strawn: I have a case of my own, at my own house, where I put in cement floor in the cellar. I mentioned this ten years ago in the Society, and the thing is working yet. The cement floor in the cellar heaved up an inch and kept raising for years until the door would not swing back. I broke it down and recoated it, and I notice that at the present time it is beginning to heave again.

STANDARD SAND FOR CEMENT TESTING.

S. B. NEWBERRY, SANDUSKY.

The methods of testing cement, especially Portland cement, have been the subject of careful study for many years by engineers in all parts of the world. In Germany and France exact specifications regarding cement tests have been established by the governments. In this country we have, as yet, no definite official standards for testing, the only generally recognized authority being the report of the committee of the American Society of Civil Engineers. This report was presented in 1885, and consists chiefly of suggestions of a general character, and gives no precise instructions as to the methods which are to be followed. It is encouraging to note that the American Society of Civil Engineers has lately taken up the subject anew, and it is expected that at the annual meeting, which is to be held in New York this month, a new committee will be appointed to investigate this important question. It will be an immense advantage to manufacturers and engineers, if a set of requirements can be adopted for this country, which shall give clear and full instructions as to the exact methods to be followed and results to be required. At present every engineer follows his own methods, and the results obtained by different experimentors are by no means comparative. Even the United States government has established no standard requirements, and the specifications sent out by government engineers for various contracts differ in a marked degree. In one set of specifications we find most severe requirements, while another set would admit cements of most ordinary quality.

Probably the most complete official requirements are those of Germany, issued by the minister of public works. These have been modified and perfected for many years, and in their preparation the government has had the aid of the Association of German Portland Cement Manufacturers., and the Royal Testing Station at Charlottenburg. I have here a number of copies of a pamphlet on cement testing, which gives a synopsis of the stand-

ard requirements of various countries, including the recommendations of the American Society of Civil Engineers. I should be pleased to send a copy of this pamphlet to any member of this Society who will send me his address for this purpose.

The German requirements specify that cement is to be tested with three parts normal sand. Tests of neat cement are not recognized, since it is well known that a cement coarsely ground will give as high results when tested neat as the same cement finely ground. With sand, however, the fineness of grinding shows its effect at once in greatly improved tests. Further, many cements that are unsound, and have a tendency to expand and go to pieces at long periods, show remarkable neat tests at seven or twenty-eight days. With sand, the rottenness of such cements is at once apparent.

The requirement that tensile and compression tests shall be made with three parts sand, by weight, rather than with one or two parts, has for its object the determination of the actual adhesive qualities of the cement. The normal sand contains about 40 per cent. of voids. In a mixture of one part of cement with two and a half parts of sand, therefore, the voids would be completely filled, and the results would be a good deal like those obtained with neat cement. With three parts of sand, however, a certain part of the voids remain unfilled, and the true cementing power of the material, due to its hydraulic properties and fine grinding, becomes apparent.

The "normal sand" used in Germany is the clean quartz sand from Freienwalde on the Oder river, screened to pass a sieve of twenty meshes to the linear inch, and retained on one of twenty-eight meshes. The German requirements specify that Portland cement, tested with three parts sand, shall show at twenty-eight days a tensile strength of at least 224 pounds, and a compression strength of 2,240 pounds.

The briquettes and compression cubes for sand tests must be made with great care if uniform results are to be obtained. The German requirements give full details of the methods to be followed. Still more exact instructions are given in a recent report by M. Gary on the apparatus and methods used in testing

cements at the Royal Testing Station at Charlottenburg. I have here a copy of this report, with illustrations of the apparatus employed, and am preparing an abstract of it for the Engineering News. The German requirements specify that the cement and sand for five briquettes shall be mixed dry in a metal cup, by means of a spatula. Water to the amount of 10 per cent. is then added, and the mixture thoroughly worked in the cup for at least five minutes. On the thoroughness of this mixing and working the results are largely dependent. Various machines for this purpose have been proposed, to replace hand labor, and are now under trial at the German Royal Testing Station. The briquettes are made by the Boehme hammer apparatus (each briquette receiving 150 strokes from a hammer weighing two kilogrammes), or by hand. In the latter case a spatula of given weight and dimensions is employed. The molds are filled above the top, and the mass rapped with the spatula until it appears elastic and water shows on the surface. Briquettes are kept in a zinc-lined box for twenty-four hours, then placed in water.

In the United States, the only standard sand recognized is the crushed quartz used in the manufacture of sandpaper, as recommended by the American Society of Civil Engineers. Here are specimens of this crushed quartz, and also of the German normal sand. The quartz is very different from the sand, as it consists of sharp, glossy splinters, while the sand consists of nearly spherical grains, rough like ground glass on the surface. Comparative tests of the voids in these two materials gave the following results:

Standard crushed quarts, 20-30 mesh, 48.2 per cent.; German normal sand, 20-28 mesh, 39.0 per cent.

From this it would be expected that the standard crushed quartz would give lower results when used in testing cements. This, however, has not proved to be the case. Comparative tests of this question are now in progress, and will be complete in time to be included in the published proceedings of this meeting.

One great drawback to the use of the standard quartz is its high cost, amounting to about $10 per barrel.

Its great difference in character from the sands used in prac-

tice is also considered by many to be a decided objection. It is, therefore, greatly to be desired that a standard sand should be selected in this country, coming from a deposit of such extent and uniformity as to insure a constant supply of unvarying material for a long period of years.

I have made some search for a deposit of sand of this character, but have not, as yet, found a deposit which is comparable in extent of quality to the German beds at Freienwalde. Most deposits of clean sand are too fine and yield only a small percentage of sand of normal size (20 to 30 mesh). I have here specimens of the same from the north shore of Long Island, which is largely used for building purposes in New York City, and also of the sand pumped up from the bottom of the lake and bay at Sandusky, O. The Long Island sand contains some opaque, soft grains, and is far from being as pure a quartz sand as the German. The Sandusky sand contains a few fragments of shells, which are an objection, as variation in the proportion of these would lead to uncertain results.

It may be that some member of this society can suggest a deposit of pure quartz sand similar to the normal sand of Germany. If so, I should be very glad to receive specimens, and will have them carefully tested, in comparison with the German normal sand, and report the results at the next meeting. It is in the hope of receiving suggestions of this kind that this paper is presented.

The following table shows the results obtained in testing a standard German and an American Portland cement with three parts sand of various kinds. Figures show tensile strength, average of four briquettes in each case, in pounds per square inch:

	GERMAN PORTLAND CEMENT.			AMERICAN PORTLAND CEMENT.		
	7 Days.	28 Days.	1 Year.	7 Days.	28 Days.	1 Year.
Standard crushed quartz.	285	342	......	323	387	....
	....	.. ....	....	....	....	......
Long Island sand	226	311	....	276	345	....
	....	....	....	....	....	....

DISCUSSION.

Mr. Brown: I would like to ask if you use the German machine for making briquettes, or whether you make them by hand?

Professor Newberry: At our factory we do not use the German machine. I always hesitate to recommend it and to use it, because I believe that sufficiently accurate results can be obtained by hand labor, and I think the method adopted should be one which can be followed by any engineer. Very few engineers would have a German hammer, and briquettes made that way cannot be compared with those made by hand. Our experiments are made by the same experimentor doing the work, mixing a certain number of minutes, at a uniform temperature, and thus get uniform results, briquettes made at the same time and of the same material showing very little variation. And I think the method can be so accurately defined that fairly uniform results can be obtained by different experiments if we only follow the method as laid down in Germany. I am in favor of making them by hand. All we want as engineers is to have a method established to which we can turn and find just exactly what to do. If we have a certain method which will always give accurate results, it is easy to follow. If you say to take a room at 70 degrees, take three ounces of cement and nine ounces of sand, mix one minute in a cup with a spatula, add so much water and work five or three minutes by the clock, press firmly into moulds so as to fill above the top and pound for perhaps a minute, until water appears on the surface. If the method is followed carefully we will have uniform results. What I am in favor of is such investigation and description as can be found and adapted for definite experiment in detail, so that when work is to be done, if we do it that way, the work will be right.

CEMENT CULVERTS.

GEO. W. BARTHOLOMEW, BELLEFONTAINE.

Mr. President and Gentlemen:

I will make a few remarks concerning the cost of county pike culverts, especially concrete culverts. For ten years I have had to drive almost daily over a county pike that has about thirty culverts, nearly all of which have had to be repaired or rebuilt during that time. When I first stopped to examine one of them that was being repaired, I suggested to the county commissioner who was looking after it that the county try a Portland cement concrete culvert when they had to rebuild the next one. The commissioners did so, and have since repeated it with great satisfaction to everyone concerned.

When Professor Brown asked me to furnish a little something for this meeting, I thought of these cement culverts and the economy to the county in a long term of years. A search of the county records showed that there are some 450 miles of pike, with an average of about six culverts to the mile, making about 2,700 culverts on the pikes. There are over 600 miles of other roads, having about the same number of culverts, but those are not considered in this for lack of data concerning them. These pikes were planned and constructed under engineers as competent, perhaps, and faithful as the average engineer.

Examinations of the records, profiles and specifications of the pikes and thorough inquiries were made to learn the number of each kind of culvert, and their cost and durability. Fortunately, the same man has had charge of culverts and bridges for the last seventeen years, and with his aid and that of the engineers, and by going over pike after pike with this problem in view, a tolerably accurate idea was obtained. This data, as the best conveniently obtainable, as to cost of the old culverts, is given in table form.

There were of the different kinds of culverts about one-fourth or 6.75 of each kind, wood, sewer pipe, stone box and stone arch. They averaged 36 feet long. The standard

forms and sizes were used. The stone box, wood and sewer pipe culverts had no end walls, and very few arch culverts had wing walls, so wing walls are not included in this estimate.

The stone was from local quarries. From the bottom stratas of the corniferous or the top of the Helderberg limestone, which is fairly good stone compared with usual local stone. The average haul of stone was seven miles. The cost of the masonry in place is about $7.00 per perch. When Berea stone was used it was about $10.50, but to simplify matters, no attention was paid to the Berea stone, and all were figured at $7.00 per perch. The oak lumber was figured at $20 per thousand, and the sewer pipe about 75 per cent. off.

The different kinds of culverts were found to be renewed on an average as follows:

Wooden box and sewer pipe about every eight years, the specially thick sewer pipe not lasting much longer than the ordinary. The stone box culverts were renewed about every ten years; the stone arch culverts about every twenty years.

The expense of repairs was great, but to simplify the matter, were not considered. The sewer pipe culverts had to be repaired constantly. When full of frost they do not stand much of a blow or sudden strain.

The stone box culverts were usually carelessly and cheaply constructed, the wall being composed of one tier of stones unfit for the purpose, backed by small quarry spalls. The mortar was of natural cement, Louisville or New York, or lime, and had probably disappeared after the first freezing while the culvert was wet. The stones had also been scaled and cracked until they were nearly half gone if the culvert was ten years old.

The stone arch culverts, while better constructed than the box culverts, were many of them in very bad shape. Water had frozen back of, between and in the arch and side wall stones, displacing and breaking them up. But the layers of stone that were above low water, but wet by the strain, were invariably, after a few years, in bad shape, broken up, displaced, pushed in towards the water and often pushed entirely into the stream. The mortar

in them was as scarce, especially where the water and freezing had reached it, as in the box culverts.

The disintegrating effect of the freezing of the water in the stone was seen in the stream below, the bottom of which for twenty feet or more would be paved with scales and spalls frozen from the arch and side wall stones. Winrows of spalls would sometimes lay along each bench wall twelve to eighteen inches deep.

The point sought to be emphasized is that all of these culverts, as they are usually erected are, in this and colder climates, very short lived and very expensive in the long run. This information is tabulatd, with calculations as to the cost to the county of renewing each of the 2,700 culverts for 100 years:

TABLE A.

CULVERTS.

KIND.	Span Inches	No. in County Pikes.	Average Cost.	Total Cost of All.	No. Renewals 100 Yrs.	Total Cost per 100 Years.
Wood Box..........	12	162	$23.50			
	24	324	33.00			
	36	189	40.00	$22,000	12½	$ 275,000
Sewer Pipe..........	12	54	16.40			
	18	40	32.00			
	20 & 21	189	44.00			
	24	27	63.00	12,200	12½	152,500
Stone Box	18	135	30.00			
	24	324	38.00			
	30	108	44.00			
	36	54	78.00			
	42	27	104.00			
	48	27	116.00	31,200	10	312,000
Stone Arch..........	36	27	200.00			
	48	162	250.00			
	72	324	334.00			
	96	84	505.00			
	120	54	707.00			
	144	27	976.00	281,000	5	1,305,000
						2,044,000

Of late years iron pipe has been used considerably. Railroads especially have used it for small culverts regardless of its great cost, on account of the convenience of placing it under their tracks while their trains are running. Even this costly article is liable to be bad when placed. A number were found broken. Every foundryman knows the great care necessary in

the successful running and cooling of large castings to avoid more contraction on one side than on the other, the severe tension that follows often cracking them immediately, but frequently waiting for some jar before breaking

When filled with frost and a blow from some heavily loaded wheel jars them, such defective pipe are liable to break. They certainly will rust out in time. Culverts made of iron pipe cost more than twice as much as those made of concrete.

See table of estimated cost of iron pipe culverts, counting them at about 50 per cent. off. Iron pipe should have end walls of masonry, but the expense of such was not included:

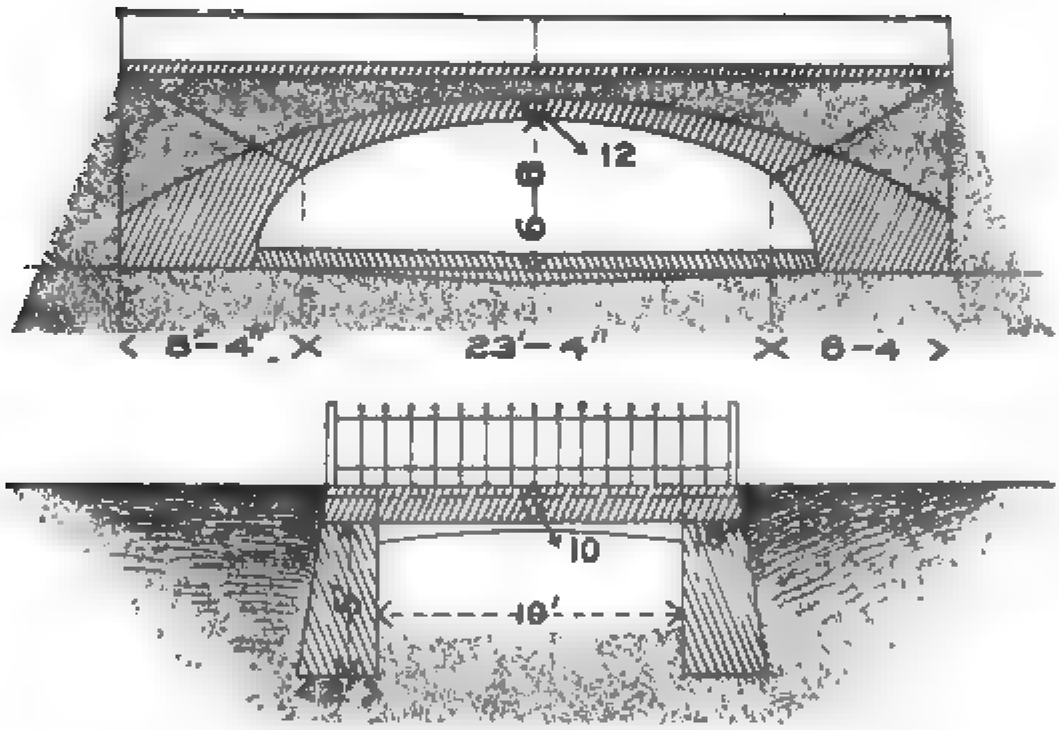
TABLE B.

Cost of Iron Pipe Culverts in place, 36 feet long.

DIAMETER.	Cost at Depot per Foot. (About 50% Off.)	Hauling 7 Miles.	Excavation and Filling	PLACING.	TOTAL.
14	1.30	$ 5.00	$ 8.00	$1.00	$ 60.00
20	2.25	7.50	18.60	1.50	108.00
24	2.65	10.00	20.00	2.00	127.C0
30	3.65	15.00	18.00	2.50	166.00
36	5.50	18.00	20.00	3.00	250.00
42	7.00	20.00	20.00	4.00	300.00
48	8.50	30.00	25.00	5.00	366.00
60	17.00	50.00	28.00	10.00	700.00

The concrete arch culverts of this county were built comparatively recently, about four years ago, and nine years ago, Portland cement and gravel were used. They are as perfect even to the smallest minutia today as they were when built. It is reasonable to consider them, comparatively speaking, indestructible from natural causes. Their cubical contents are only about two-thirds that of the standard masonry culverts. The cost per yard is about three-fourths that of the limestone masonry. And as the Portland cement culvert, if properly built, will last for hundreds of years, the saving to a county in any long period would be enormous.

To more fully show this, the cost of Portland cement culverts has been figured out, showing form and dimensions used for each size, or diameter, of culvert, the general form being that



Diagrams of Actual Concrete Culverts.

of a flat bottom drain tile, but the opening being round. Where this is found to be too high an oval can be used.

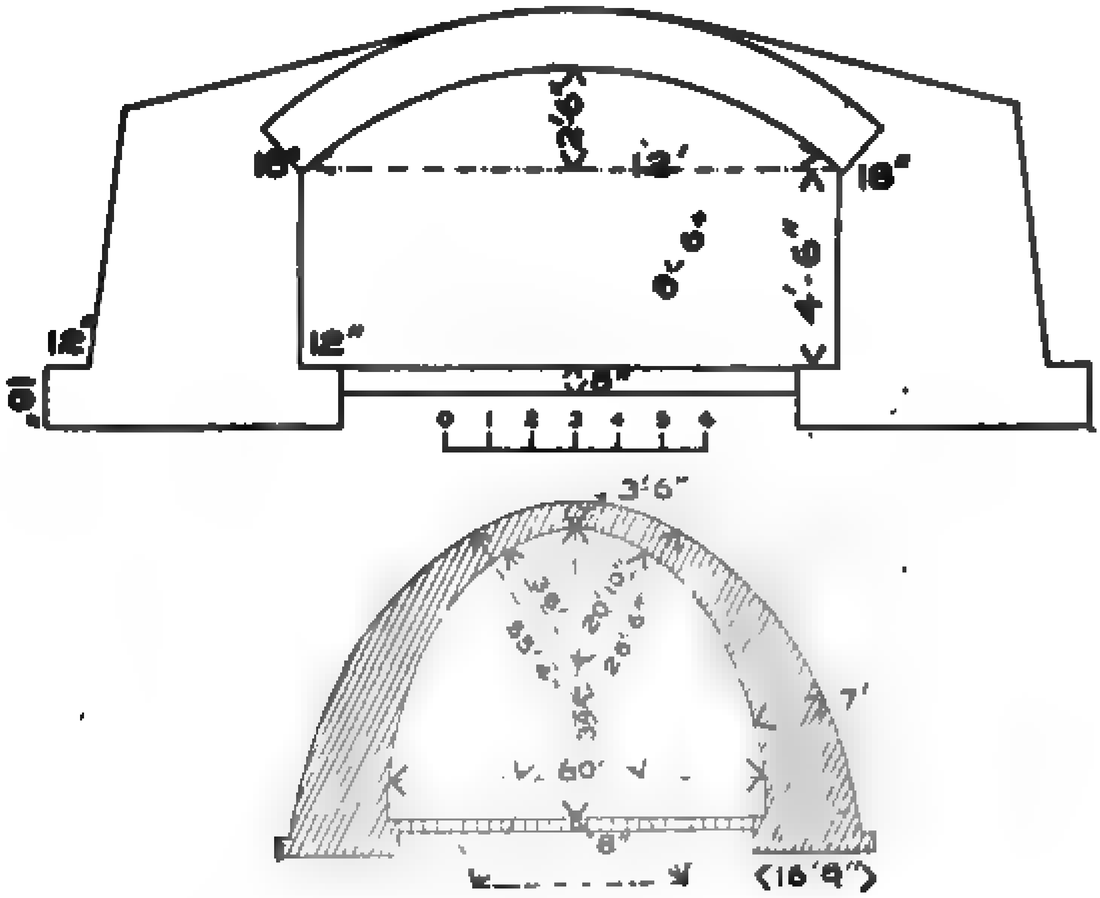
TABLE C.

Cost of 2700 Concrete Culverts of size corresponding to that of the other culverts of the county.

The 48 inch and larger have end walls.

SPAN.	No. Corresponding Size in County.	Width of Base	Least Thickness of Foundation.	CROWN.	Cubic Yards.	Cost at $3.50.	Cost at $5.25.	Excavating and Filling.	TOTAL.	Total Cost for Whole Number.
14	216	24	6	[illegible]	3.96	$ 14.00	$ 21.00	$ 8.00	$ 29	$ 6,265
20	729	34	6	5	6.50	22 00	33 00	18.60	[illegible]	37,900
24	675	42	7	6	8.46	29.65	44.00	20.00	[illegible]	45,900
30	297	48	8	6	11.00	38.50	58.00	18.00	76	22,275
36	71	54	8	6	15.12	[illegible]	80.00	20.00	100	7,100
[illegible]	27	62	10	7	18.36	64.25	97.00	20.00	117	3,150
48	189	68	10	7	22.52	78.82	118.50	25.00	155	29,300
60	...	84	12	8	33.46	117.21	175 00	25.00	200	.....
[illegible]	324	96	12	8	40.36	141.26	212.00	30.00	245	79,400
96	84	124	14	9	63.24	211.34	320.00	40.00	[illegible]	30,260
120	54	150	14	10	84.96	298.86	450.00	[illegible]	500	27,000
144	[illegible]	174	16	10	96.84	339.44	500.00	60.00	560	15,120
										$353,640

The table also shows what 2,700 Portland cement culverts of the same capacity of those heretofore described, would cost in place, it being only $350,000, while the others are shown to have cost at the rate of about $2,000,000 per hundred years. This comparison presumes that the Portland cement culvert will last 100 years. You ask what evidence there is that it will do so? Portland cement has not been in use 100 years. It has not been in general use for large concrete construction only about thirty odd years. Some of the work done at that time are the docks and sea walls of England. This work was done with



Examples of German Practice.

cement much inferior to the present article, yet even then seven to sixteen parts of gravel and stone were used to one part cement, and the work is in good shape now. The great Chatham, England, docks and arches built in 1867, using largely twelve parts of gravel to one of cement, are so satisfactory that that proportion has been used ever since.

The concrete work at Woolwich, England, and elsewhere

in England and Europe, of sixty to 100 years ago, was built with lime and pozulana—a cement much inferior to any cement made today. Yet those walls have stood the sea waves all this time without serious injury. But the strongest evidence is the old Roman concrete work at Pevensey, Richmond and Rochester, England, and in the sea walls of Italy that have stood the never ceasing battling with the elements for 2,000 years.

But you ask, will the cement work be any better constructed than the stone work was? I answer, yes, if the county will furnish the material. There should then be no doubt about the quality and quantity being used, and in every county there are now experienced cement workmen.

DISCUSSION.

A Member: How large is the largest of the culverts you built of concrete?

Mr. Bartholomew: The largest is six feet in diameter. We do not depend upon our own experience in this matter, but upon others. There is no limit to the size. Bridges are being built throughout of concrete.

Chairman Strawn: Would you still maintain the same form?

Mr. Bartholomew: Yes, sir. That general form applies to all concrete culverts. It is to be used for any size.

Chairman Strawn: I will ask the engineers if there can be any criticism to the form I have suggested (indicating modification made on Mr. Bartholomew's diagram), giving greater water way and also saving very materially in the yardage of your structure?

A Member: There would be the same objection as in the case of a flat bottomed ditch, except in this case it would be hard and smooth. A thin layer of water will not flow over so rapidly and will leave a deposit of sand; with a sharper curve it will more readily clear itself of any material.

Mr. Kinnear: Is that construction as strong as the circular?

Chairman Strawn: This (indicating) is supposed to still

increase the strength of your abutment and I can see no reason why we cannot make them substantially in that form.

Mr. Gilpatrick: I would like to suggest that the construction of the center is a very small matter of expense; but everything that passes out of uniform construction will add to cost of construction.

Chairman Strawn: This is for a culvert, not a sewer. The reason why I suggest this is that I have known that form to stand in perfect shape and perform all the offices necessary.

Colonel Innis: I will say, Mr. Chairman, I think I have been superintendent of either a turnpike or plank road for [illegible] or 30 years, with culverts, and I do not remember one single instance where the sediment in the culvert caused any trouble. All the trouble was caused by the washing out of the culverts. I have even gone to the trouble to put a big stone in the stream below to keep them from washing out. If a culvert is put down well in the first place it will not wash out. Unfortunately they are not put down well, often. I had a road [illegible] who said he could not afford to put it down well into the ground; it would cost too much, and I remember in one case of [illegible] he wanted to build them on top of the ground. [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

where they have to haul sand or gravel three miles at least, but where they have clay to make brick right next to the road.

Chairman Strawn: It seems to me it is a matter of economy, and we must depend largely upon contingencies of the locality where the improvement is made.

Mr. McKay: Last year I had charge of some tunnels for steam pipes, five feet in height and four feet in width in the clear. I recommended a cement concrete, but others seemed to be so much afraid of it they would not adopt it, and I would like to ask the opinion of the members as to using concrete instead of brick for such purpose.

Chairman Strawn: Some of our people have not been educated up to the real value of concrete. Our county commissioners have certainly not appreciated its merits, and many contractors and builders are coming that way and beginning to appreciate the value of concrete. In Toledo most all the buildings have concrete foundations, and in Cleveland, where 25 years ago you could not find a concrete foundation anywhere, it is being largely used.

Mr. McKay: I will ask Mr. Brown, are your tunnels for steam pipe constructed of brick?

Mr. Brown: Of brick.

Mr. Newbury: Regarding the question asked as to the comparison of a concrete and brick, I have made a rapid calculation here. Taking 22 red brick to the cubic foot, which I think is correct, 1,000 brick would make 45 cubic feet. Figure this brick at $5 a thousand. Taking concrete one to eight, 45 cubic feet is equivalent to 1,000 brick. This would require for cement $3; sand and gravel at $1 a yard, $1.50; which would make the materials for 45 cubic feet: Brick $5, concrete $4.50. That is not counting anything for the mortar in the brick. In regard to the labor in concrete, it is less than brick work. It is cheaper because necessarily not so skillful.

Mr. Gilpatrick: Give me a word here. This member (indicating Mr. Kinnear) made a remark here that I hope he will make to the Society; criticisms on cement sewers, whether desirable or otherwise.

Mr. Kinnear: I do not know whether I could give that statement satisfactorily. At one time Colonel Waring became very much interested in concrete. I was acquainted with him at that time and he had prepared a concrete or cement pipe for sewers. He sent me a sample from New Jersey, and I was much taken with it. It was in sections and seemed just the thing. Afterwards I saw a good deal of criticism, either in a pamphlet or a circular, about the failure of that class of sewer pipe. I cannot give any personal knowledge. It was simply something I read. It rather saddened my ideas on cement pipe, although I am a great advocate of good cement concrete. It is one of the materials which has been neglected too long. I have fully made up my mind that in all my work after this I will use nothing but the best class of cement.

Mr. Bartholomew: I am neither an engineer nor sewer builder, but in my reading I am always interested wherever cement is used, and I have noticed that in the city of Brooklyn, for twelve years or more, they have been using cement for sewers and cement pipe wherever they needed small pipe for any purposes. Also in Newark and Jersey City it is very largely used. They continue to use it and are satisfied.

Mr. Kinnear: Do you know how it is made?

Mr. Bartholomew: The most of it is made in moulds and placed in the ground. The other is made in the ground with flat coiled center. I cannot give you the name of the patentee, but it is said to be very satisfactory. He winds it around a bar or pole and then builds his concrete around it and pulls it out at the end and continues with 50 foot lengths. It seems to be an economical manner of making continuous pipe.

Mr. White: I understand the government engineer at New York City has condemned the use of limestone in concrete. I would like to know if any one present has had any experience in that line.

Mr. Bartholomew: I think I read almost everything printed on cement, and I never saw anything of that. Limestone

is used the world over in cement, and if it ruins concrete it is a great discoverv.

Mr. White: The statement was made in a magazine published by the Municipal Paving Co.

Mr. Kinnear: Bear in mind one thing, that whatever you see in the newspapers is absolutely correct. (Laughter.)

Mr. Judson: I know by experience that it is one of the most difficult things in the world to get a stone mason or contractor to make good concrete. It can be made very easily, but requires thorough mixing, material prepared properly and the average contractor is not inclined to give it the required care and attention unless you watch him carefully. There is much material used called concrete, which fails, and for that reason probably the public has been prejudiced against it.

Mr. Stump: I would like to ask in using that for a large culvert what would you have for an outlet. Seems to me it would not do to make it entirely of that concrete.

Mr. Bartholomew: There is no trouble in the world in laying blocks of concrete at the outlet and there is nothing better.

Colonel Innis: How would a block of stone do?

Mr. McKay: It is better than stone.

Mr. Bartholomew: I have seen a great deal of concrete. I have spent ten years of every day life in the business. There are nearly always two conditions most necessary to secure good cement work, quantity of cement and quality of other material.

Chairman Strawn: With sense in mixing—I must put that in. I can refer to two jobs of work done in our city at the same time, two sidewalks built. One man, in order to get an excellent quality of work, got crushed stone at Massillon. He was a dealer in cement and anxious to get the finest possible job. I was having some walks built around my own place at the same time of Portland cement also. The walk he put in went all to pieces the first winter. Mine has been down five years and I think any one will say that it is as nice now as the first week after it was laid. I mixed it myself.

A Member: What did it cost per square foot.

Chairman Strawn: About 8 cents for material and the labor expended on it.

A Member: What cement did you use?

Chairman Strawn: Buckeye Portland cement.

A Member: What was the depth of the completed structure?

Chairman Strawn: The ground was descending at the rate of about two feet and a half in a hundred feet, so the drainage was all right. I put in eight or nine inches of coarse gravel, made thoroughly solid by ramming. Then the base of concrete, making it a very little thicker in the center of the walk to about three inches, mixing it one part cement and seven parts gravel. The top part of sharp sand, mixed one part cement to two of sand. The difference in the cost when they come to count the advantage gained by Portland cement, having the quality of going farther than ordinary cement, is small.

A Member: What is the depth of the top?

Chairman Strawn: One inch, and the bottom probably three and a half in the center.

Mr. McKay: Is it not bad policy to mix two different brands of cement in pavements, anyhow?

Chairman Strawn: I never could see why one should try to economize so closely as to mix it.

Mr. Bartholomew: Under no circumstances use natural cement in sidewalks. I have seen thousands of failures from it.

A Member: What is the best to use?

Mr. Bartholomew: Buy Portland.

Mr. Gilpatrick: Do you account for the failure of your neighbor and the success of yourself in the mixing, and not in the sand?

Chairman Strawn: The whole trouble was, that man had an expert plasterer to mix the cement and lay the walk, an Englishman who had his ways as fixed as a rock. He worked it too much. He had better sand than I had, but it was the fault of the workman. That is the reason I said there must be good sense used in mixing. I have had more trouble in the last eight

or ten years in cement work, from men who claim to be masons or plasterers than ordinary workmen who used good sense.

Mr. Bowden: In connection with my father I have had considerable experience in the matter of cement walks. We have built many cement walks with concrete in the bottom and in almost every case it went to pieces. We have tried putting Portland cement on top, but it scales off eventually. We have found that it is much cheaper to make a walk of flag stone than entirely of Portland cement, and it is liked better than cement work. We have gone into laying flagstone and have it down to 11 cents a foot. That is Grafton flagstone.

Professor Newberry: I think it is true that flagstone walks, two or two and a half inch flagging, can be laid cheaper than cement. They are laid for 9 cents in Cleveland, where the cement is 13 cents a foot. In business stores, where it is necessary to have it thicker, it is cheaper to put cement than flagstone four inches deep.

Mr. Snow: I would like to go one better. I had a walk put in this fall for 8 cents, laid of sawed stone flagging.

Mr. Bartholomew detailed at length tests made of cubes of marble, Berea limestone, granite, concrete, etc., in Germany, at Boston and at Bellefontaine. The tests were made to show the comparative wearing qualities, the samples being placed in a machine under pressure and exposed to the action of a grindstone run at a regular rate of speed for a certain length of time, the blocks of cement wearing forty times as long as Berea sandstone.

Chairman Strawn: It is becoming almost universal now in Chicago to use cement walks. I went to quite a good deal of pains to inform myself in the matter while there and found cement walks being laid in almost every quarter of the city, with scarcely a single stone walk being put down anywhere.

A Member: It is true in Cleveland also, with flagstone quarries in the city limits. The very best streets are using cement walks. I am heartily glad to hear this discussion, because I am personally very much interested, and hope to see others come to the appreciation of what I think is one of the most valuable ingredients in masonry.

Mr. Snow: I want to ask whether any gentlemen here have used Portland cement for cross walks in streets.

Mr. Bartholomew: I do not like to reply to everything, but it comes in my line. Cross walks of cement are very commonly used in southern Michigan and northern Indiana. Most of the leading towns have them, made of Portland cement, about five or six inches thick. Its use in streets has been growing. You may or not know that in Bellefontaine we have four streets paved with Portland cement, the entire street, and it is an absolute success.

Chairman Strawn: How long have they been down?

Mr. Bartholomew: The first street was laid six years ago, the second six years ago and two four years ago; and there is not any wear on those streets, except where the blocks come together. They were put in in blocks 5 and 6 feet square, but should not have been put in on a line parallel with the street, but should have been put in on an angle with the street. The result is there has been a slight wear in the center blocks on the edge, but not a wear that would be noticeable. This street bears the heaviest traffic in the city, but the test is not as severe as upon another street, where teams are standing all the time in front of the stores, fourteen hours a day, with the horses stamping continually. That street has not been touched in seven years and there is no depression showing. The concrete is six inches. Two of the streets were built on the old surface. My experience is that if you have a good solid roadbed that is well drained, you cannot better it as a foundation for asphalt or concrete by taking it out and putting in broken stone. But you must be sure it is well drained.

A Member: How large are the blocks?

Mr. Bartholomew: The blocks are five and six feet square, and they can be readily taken up. Over the gas and water pipes they are made like a keystone to an arch, and they can be turned over to repair the pipes and then replaced in their former position.

Mr. Snow: What is the cost, as compared to asphalt?

Mr. Bartholomew: The cost was $2.15 per square yard, including excavating, putting in tile drains, curbs on the side of cement.

A Member: Is it ever slippery?

Mr. Bartholomew: No more so—not as much so as wet asphalt and not more so than vitrified brick. In that respect it is no more objectionable than any solid pavement.

REPORT OF COMMITTEE ON INSTRUMENTS AND EXHIBITS.

HARRY M. GATES, COLUMBUS.

Report of Committee on Instruments and Exhibits was read by Harry M. Gates, as follows:

Columbus, Ohio, January, 20, 1897.

The Committee on Instruments and Exhibits desires to make the following report:

Not having had audience with any of the other members of the committee, I will endeavor to perform my duty as best I can.

We have only two exhibits on hand, those of Messrs. Ulmer & Hoff, of Cleveland, O., and Mr. Leo Veit, of Columbus.

There was, among the instruments exhibited by Messrs. Ulmer & Hoff, of Cleveland, O., a J. B. Davis' (patent) solar transit as made by them. This instrument deserves special mention, not only on account of excellent workmanship and design, but also by reason of its being a new departure in solar construction. In this instrument there is only one telescope being used for solar work, the only addition to the transit being that of a simple plane reflector, secured to the object end of a telescope, capable of rotative motion in its transverse axis, (thus forming a permanently fixed polar axis) for the purpose of determining the true meridian. By this combination the usual solar adjustments are eliminated and only the ordinary transit adjustments are required. The other instruments shown by Messrs. Ulmer & Hoff are a plain single vernier transit without needle, a light mountain transit, an 18 inch Y level, besides numerous tapes, plumb-bobs, etc.

Mr. Leo Veit exhibits a plain engineer's transit and level, both of his own make.

There is an instrument, not an exhibit, to which I desire to call the attention of the profession, and that is a protractor made by Browne & Sharpe. This protractor is very plain and simple and reads from two to five minutes, according to design of the

instrument, and sells from $6 to $7.50. I have used it a great deal and find it very convenient and accurate.

I desire to call attention to those engaged in surveying, and especially to those just starting into business, to the manner of preserving and filing plats and records. When I began business, I did as many others have done, pasting the copies of plats into a scrap book. This method, while very satisfactory in preserving the records, is of great inconvenience for several reasons.

In the first place, the scrap book is large and requires a vault to keep it safe from fire. Another objection is that when you are called upon to make a survey you must first take a copy of the plats necessary for said survey. This takes time and sometimes this is a very precious element. I advocate and have adopted the plan of placing the plats in manilla envelopes with an opening at the end and placing these envelopes in file boxes, numbering these boxes according to the number of plats they will contain. The advantage of this method will readily be seen—the plats are ready for use at all times, and can be kept in any ordinary safe.

PRESSURE AND STABILITY OF EARTH.

W. C. PARMLEY, CLEVELAND.

Literature pertaining to the pressure and resistance of earth is very scanty. Hardly a structure of any importance can be designed without involving a knowledge of the actual pressure of earth or its ability to resist pressure. The lack of definite information on this subject is doubtless due to the varying nature of the different earths and to the variations in character of the same soil at different times.

The actual pressure that any partical of earth will exert, or the pressure that it is capable of sustaining cannot be accurately foretold, and experiments so far as made are somewhat conflicting. Owing to the uncertainties involved, some engineers reject as untrustworthy and misleading all theory relating to the pressure of earth. The author, however, believes that a cautious application of theory is often valuable in fixing limits beyond which it is unsafe to go. In order to understand the relation between theory and fact and the mutual aid one is to the other, we will first discuss the resulting formulas of Rankine's theory and then compare them with results of experience.

Earth may exert its force in two ways, first by an active pressure or thrust, and second, by a passive resistance. In order to properly understand the subject it is necessary that this distinction be kept clearly in mind. The following formulas of Rankine are taken because they are believed to be the simplest and most trustworthy of any yet proposed. Results only will be stated and reference is made for their derivation to his works on Analytical Mechanics and Civil Engineering.

The active pressure of the earth is exerted in two principal directions: First, vertically, and second, horizontally.

Let w= the weight of a unit volume of earth, x= the depth below the surface of the plane against which the pressure is exerted, a= equal the area of the plane, A=the inclination of the plane to the horizontal, B= the angle of repose of the earth.

Then the vertical pressure against the plane is:

$$(1)\quad p=w\ x\ a\cos A$$

which is simply the symbolic way of stating that the vertical pressure is the weight of the prism of earth vertically above the surface in question.

The pressure latterally upon a surface of unit length and depth x, is:

$$(2)\quad p_x=\frac{w\ x^2}{2}\ \frac{1-\sin B}{1+\sin B}$$

The stability or resistance of earth laterally upon the same surface is:

$$(3)\quad p_y=\frac{w\ x^2}{2}\ \frac{1+\sin B}{1-\sin B}$$

The supporting power of earth vertically per unit area is:

$$(4)\quad p_z=w\ x\left(\frac{1+\sin B}{1-\sin B}\right)^2$$

Formulas 1 and 2 give active pressure or thrust of earth. Formulas 3 and 4 give the resistance of earth to pressure.

Formulas for earth pressure can be more conveniently used if they are translated into the equivalent fluid pressure, and a more intelligent understanding of them is obtained by comparing the pressure of earth with that of water. Now, since water presses equally in all directions, the lateral pressure of water against a submerged vertical surface of unit length and of depth x, is:

$p=\frac{w\ x^2}{2}$, in which w=the weight of one cubic foot of water.

Comparing this with formula 2 it is evident that the earth will exert a pressure laterally equivalent to that of a fluid which weighs

$$w\ \frac{1-\sin B}{1+\sin B}$$

pounds per cubic foot. In like manner, the equivalent fluid pressure for the horizontal resistance and vertical resistance is respectively,

$$w\ \frac{1+\sin B}{1-\sin B}\ \text{and}\ w\left(\frac{1+\sin B}{1-\sin B}\right)^2$$

For example, the pressure of earth weighing 100 pounds per cubic foot, by the above theory, if the angle of repose is $1\frac{1}{2}:1$, is equivalent to that exerted by a fluid whose weight per cubic foot is:

For active pressure laterally, $100\,\frac{1-\sin 33^\circ 40'}{1+\sin 33^\circ 40'}=28.8$ pounds per cubic foot.

For passive pressure laterally, $100\,\frac{1+\sin 33^\circ 40'}{1-\sin 33^\circ 40'}=500$ pounds per cubic foot.

For passive pressure vertically, $100\left(\frac{1+\sin 33^\circ 40'}{1-\sin 33^\circ 40'}\right)^2=$ 1220 lbs. per cubic foot.

The reliability of Rankine's theory has been called in question by many engineers, most notably by Sir Benjamin Baker, of England, in an article entitled "The Actual Lateral Pressure of Earthwork," and published in Van Notrand's Engineering Magazine, vol. 24 (1881), pp. 333 and 353. He concluded that the actual horizontal pressure of earth is only about one-half that indicated by theory. Most of his experiments and observations were upon the resistance of retaining walls to earth pressure. After careful study of this able article, I am unable to agree with the conclusions arrived at by Baker:

1. Because most of his conclusions are made from newly or only partially settled embankment.

2. Because in many cases counterforted walls were used where the increased stability of the wall from the friction of the earth on the counterforts could not be determined.

3. Because in several experimental walls of slag or coarse stones the stability of the wall was increased an unknown amount by the friction of the earth backing upon the rough back of the wall.

It is also claimed, owing to the fact that the full vertical weight of the earth does not always rest upon the structure, that therefore formula 1 gives pressure greatly in excess of that actually produced. This appears to be an erroneous conclusion.

The formula gives the actual weight if there is no settlement

of the structure and if there are no cavities or only partially compacted earth backing. But in fact, settlement usually occurs. The structure thus tends to retreat from the imposed weight and as a result the column of earth directly overhead tends to slip down to a new position thus causing frictional resistance between it and the adjacent earth. A portion of the weight is therefore transferred to the surrounding material instead of it all coming on the underlying structure. A tendency to form a natural relieving arch is thus produced and the extent to which it may reduce the actual weight carried by the structure depends upon the nature of the earth covering and upon the cohesion and compressibility of the earth.

In the case of gravel, broken stone and, in a lesser degree, sand, there is little or no cohesion. These matrials are practically incompressible also, hence they are likely to bring nearly their ultimate pressure immediately upon the structure. On the other hand, plastic clay, loam, peat, or other compressible cohesive substance may temporarily bridge over any cavity caused by settlement, but they will gradually settle or bend downward and ultimately may produce a greater pressure than would be produced if they did not possess these properties. The effect of water upon these materials is much more powerful in incrasing the pressure than it is upon sand, gravel, broken stone, or any other non-cohesive non-compressible material.

These facts, therefore, in no way nullify the rigid exactness of the law of vertical earth pressure as expressed by formula 1, but settlement may cause the pressure to be so distributed that the full weight is not borne by the given structure.

The estimated pressure that may come upon any piece of work must be based upon a careful study of the nature of the material in hand. In tunnel, through hard clay, only a small fraction of the full earth pressure is to be expected, and temporary timbering may or may not be used accordingly. Even in such cases it is not safe usually to build permanent work without providing for a considerable portion of the full pressure, as the danger of water softening the clay is usually considerable, and the clay in time, may deflect downward enough to severely tax

the strength of the work. In water bearing sand or silt, nearly or quite the full theoretical weight may ultimately rest upon the work. In dry or only moist sand and gravel, about one-half the full weight may be expected at first, but this will probably increase afterward. The greater the depth below the surface, the less will be the proportion that the actual pressure bears to the full theoretical weight.

As already stated, in attempting to disprove the theoretical intensity of the horizontal pressure of earth, Sir Benjamin Baker uses the retaining wall as his chief argument. He finds in many instances that walls sustain for a considerable time a higher bank of earth than that indicated by theory. These facts and experiments only illustrate the general law of earth pressure that its full pressure is not exerted at first owing to cohesive properties usually possessed, but as stated by Rankine, cohesion is too uncertain an element to be trusted in practice, its effect is neglected in deducing the formulas for earth pressure. That in practice it is not usually safe to expect less than the theoretical pressure, is proved by the following table, which shows the thickness of retaining walls required by theory, compared with the thickness given by standard rules resulting from centuries of actual engineering experience.

A fundamental principal in the stability of masonry structures is that the line of resistance or resultant of all the forces acting, should not depart at any point from the middle third of the masonry. Let us take, therefore, for illustration, a trapezoidal wall and determine its amount of stability on the condition that the resultant of all the forces acting shall not cut the base outside of the middle third. We can then compare the thicknesses of walls required for different kinds of materials with walls for the same materials proportioned by standard empyrical rules.

In Fig. 1, let a= width of top of wall.

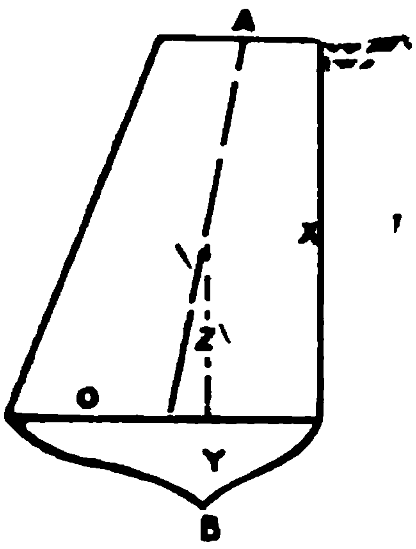


FIG. 1

b= width of bottom.

x=height of wall, with vertical back.

z=vertical distance of center of gravity of wall above the base.

y=horizontal distance of center of gravity from center of base of wall.

w=weight of one cubic foot of masonry.

The following equations may then be stated:

$$z=\frac{x\ (2a+b)}{3\ (a+b)}.$$

$$y=\frac{(b-a)\ (2a+b)}{6\ (a+b)}$$

The moment arm for the entire wall about the point O, at the outer limit of the middle third is:

Moment arm $=\frac{b}{6}+\frac{(b-a)\ (2a+b)}{6(a+b)}$, and since the weight of a unit length of wall is $w\times\frac{a+b}{2}$, the moment M of the wall about O is $M=\frac{Wx}{6}(b^2+ab-a^2)$. The moment arm for earth pressure is $\frac{x}{3}$ and the horizontal pressure of the earth is given by formula (2), hence the overturning moment of the earth pressure M, is:

$$m=\frac{wx^3}{6}\ \frac{1-\sin B}{1+\sin B}$$

For equilibrium, the moment of the earth pressure and that of the wall must be equal, hence equating the values of M and m and reducing, we get

$$b=\sqrt{1.25\ a^2+\frac{w}{W}\ \frac{1-\sin B}{1+\sin B}x^2}-\frac{a}{2}$$

which is the required thickness for the bottom of the wall in order that the resultant of all the pressure shall pass through the limit of the middle third of the base.

If the wall is not of great height so that the unit pressure upon the masonry is small, and if the earth foundation is firm so that there is no danger of settling at the toe, a retaining wall is generally considered safe if the resultant cuts the base a little nearer the front than one-third the thickness of the base. If we consider the case where the resultant cuts the bottom of the wall one-fourth the width of the base from the toe, by a similar process we get for the moment of the wall.

$$M=\frac{Wx}{24}(5b^2+5ab-4a^2)$$

and required thickness of base,

$$b=\sqrt{1.05\,a^2+.8\frac{w}{W}x\,\frac{1-\sin B}{1+\sin B}}-\frac{a}{2}$$

By the aid of the formulas already derived, the following table is computed, which gives data pertaining to earth pressure and the thickness of wall required:

TABLE 1.

1	2	3	4	5	6	7	8	9	10
Natural Slope.	Angle B	$\frac{1-\sin B}{1+\sin B}$	$W\frac{1-\sin B}{1+\sin B}$ Fluid pres.	$\frac{1+\sin B}{1-\sin B}$	$W\frac{1+\sin B}{1-\sin B}$ Fluid pres.	$\left(\frac{1+\sin B}{1-\sin B}\right)^2$	$W\left(\frac{1+\sin B}{1-\sin B}\right)^2$ Fluid pres.	Thickness of Wall.	Thickness of Wall.
½ : 1	63° 26′	.056	5.6	17.86	1790	319.0	31900.	2.08	1.79
1 : 1	45° 00′	.172	17.2	5.81	581	33.8	3370.	3.33	2.90
1½ : 1	33° 40′	.287	28.8	3.49	500	12.2	1220	4.29	3.75
2 : 1	26° 34′	.383	38.4	2.61	312	6.8	681.	4.97	4.36
2½ : 1	21° 48′	.458	45.8	2.18	218	4.8	481.	5.45	4.79
3 : 1	18° 26′	.519	51.9	1.93	193	3.7	370.	5.82	5.12
3½ : 1	15° 57′	.568	56.8	1.76	176	3.1	311.	6.10	5.36
4 : 1	14° 02′	.610	61.0	1.64	164	2.7	270.	6.34	5.58

Columns 4, 6 and 8 respectively give the equivalent fluid pressure for the active horizontal pressure, the static horizontal resistance, and the static vertical resistance for the various kinds of earth. Column 9 gives the required thickness at base for a retaining wall 10 feet high and 2 feet thick on top, in order to sustain the pressure of earth level with the top of the wall, and when the resultant of the pressure of earth and weight of wall cuts the base one-third the width of base back from the toe. Column 10 gives similar thickness for wall when the resultant cuts the base one-fourth the bottom thickness of the wall from the toe.

One cubic foot of earth is assumed to weigh 100 pounds.

One cubic foot of masonry in wall is assumed to weigh 125 pounds.

Empyrical formulas for thickness of retaining walls are derived from experience extending throughout the history of man. He has learned by failure, hence knowledge of this kind is the safest that can be applied as a criterion of theoretical results.

After reviewing a large number of observations and experiments, Benjamin Baker concludes that the bottom thickness of a retaining wall should never be less than one-fourth the height where the face batter is about 1 in 5, nor is it ever necessary to make the bottom thickness more than one-half the height. A general rule stated by the editors of the Engineering News is to make the bottom thickness three-sevenths or 43 per cent. of the height. Trautwine in his pocket book makes the thickness of wall vary from 35 to 50 per cent. of its height, depending upon the kind of wall and the kind of material composing the backing.

Turning now to the table, the natural slope of material ordinarily met in practice ranges from 1:1 to 2:1. It is very rare indeed that a wall is required to support a material having a less angle of repose than 2½:1. Comparing thicknesses of wall as given in column 9 between these ranges, we see that it accords well with the empyrical limits as above stated, and by column 10 the theoretical thicknesses required accords perhaps even better with the results of experience. This latter result is probably due to

engineers allowing the resultant of the forces to pass somewhat nearer the toe than one-third the bottom thickness of the wall. Application of the same reasoning to walls even 30 feet high and sustaining earth whose natural slope is 2½:1 gives bottom thickness about 50 per cent. of the height, thus again confirming the same conclusion.

Only one conclusion seems to be justified by this comparison, viz: That Rankine's formulas for the active vertical and lateral pressure are close approximations to the truth, and that they fix the maximum value for earth pressure. Owing to special conditions prevailing in certain cases, the pressure is not so great as that given by formula, but on account of the uncertainty of these elements, it is not safe in practice to assume a less lateral pressure than that given by formula.

With respect to the static resistance of earth against pressure, either vertically or laterally, the results of theory are much more questionable. Since Rankine's whole discussion depends upon only one principle, viz: The frictional resistance among the earth particles, and since conclusions relating to the lateral pressure are closely approximate to the truth when we consider the ultimate probable pressure of earth, we may reasonably suppose that the formulas for resistance have more than guess work as their basis.

Indirect light, however, may be shed upon the subject by the behavior of circular ring sewers under continuous exposure to earth pressures. As is well known, the tendency of circular sewers is to spread laterally opposite the center of the sewer unless there is lateral stability of the earth sufficient to resist the outward thrust of the arch. By the theory of the arch, the outward thrust upon the soil can be approximately calculated. If the sewer retains its original form, we know that the thrust is less than the soil is capable of resisting. If, on the other hand, lateral spreading occurs, we know that the limit of stability has been exceeded. Applying this process to the following cases, we are able to draw some practical conclusions regarding this obscure subject.

An exceptional sewer was built in South Bend, Ind., and

is reported by Mr. Wm. M. Whitten to be in good condition after several years of service. (Proc. Indiana Soc. Engineers, 1893.) This sewer is eliptical in form, 48 inches wide by 66 inches high, and is composed of a single ring of brick, four inches thick. Its depth in places is 23 feet below the surface, and the ground varies from good gravel to quick sand. In some places the sewer is 8 feet below the surface of ground water.

In Fig. 2, the joint of rupture is approximately calculated by the ordinary theory of least crown thrust, using 100 pounds per

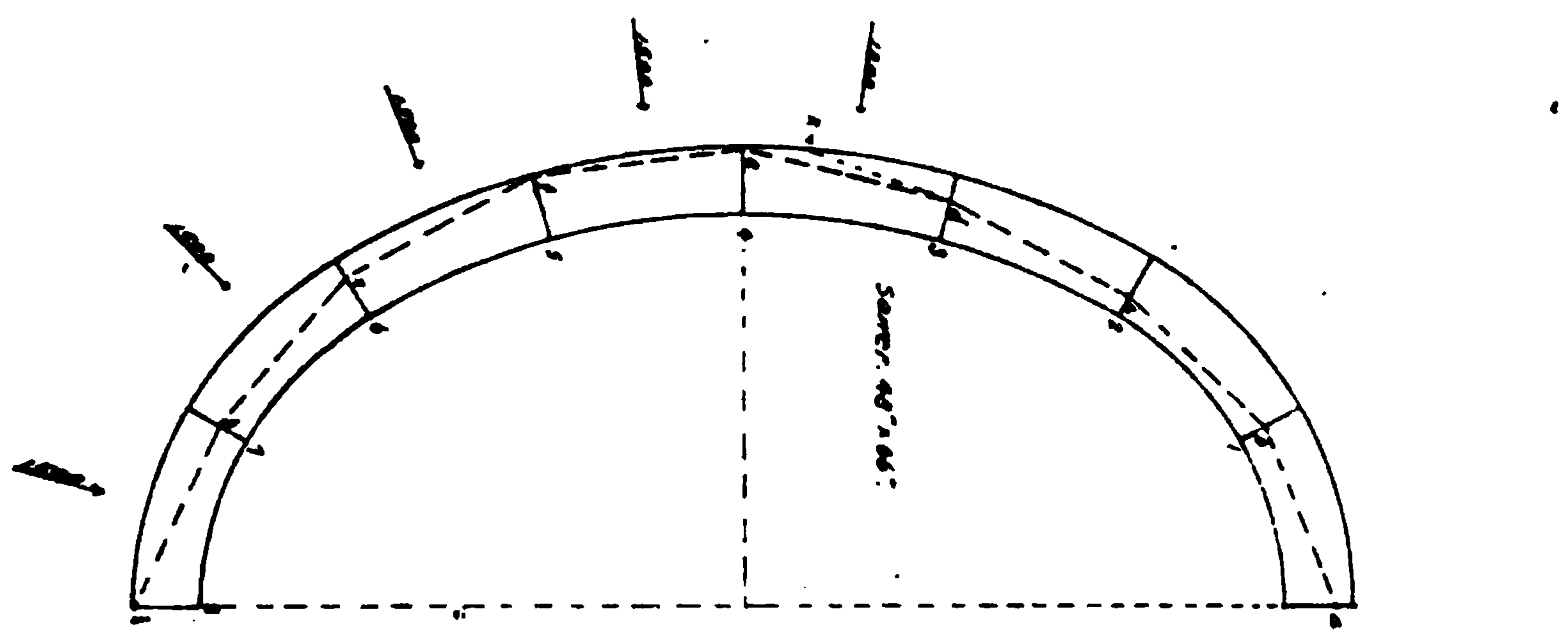


FIGURE 2.

cubic foot for the vertical pressure of the earth and 16 pounds per cubic foot equivalent fluid pressure for the horizontal earth thrust. Sixteen pounds pressure horizontally or one-half the theoretical value is about the actual pressure of newly filled material.

A crown thrust of about 2,100 pounds is thus calculated, and upon this as a base, the force polygon is drawn as far as joint 3, the joint of rupture. The line of resistance, as usual, is assumed to begin at the crown and at the upper limit of the middle third of the sewer ring. By the assumptions made, the direction, magnitude and point of application of the force upon joint 3 becomes known. It is, therefore, possible to introduce radial external resistances at the middle point of each ring which will be of sufficient intensity to keep the line of resistance inside of the sewer ring. For safety of the structure, the line of resistance should be kept within the middle third, but as in the present case, a superior quality of brick was used, forces are introduced of

sufficient intensity only to keep the line of resistance from passing outside of the sewer ring.

By calculation, it is found that beginning with an external pressure of 1,200 pounds on segment 4, and continuing with 1,500 pounds applied as shown in Fig. 2, to each of segments 5, 6, 7 and 8, the line of resistance shown by the broken line is obtained. These are the least forces that will maintain the line of resistance inside of the sewer ring. It will be noticed at joints 4, 5 and 8 that the line reaches the outer limit of the joint, hence at these points it exerts its maximum crushing force upon the brick. External pressures of 1,200 to 1,500 pounds to each segment are equivalent to from 1,100 to 1,400 pounds per square foot pressure radially and inwardly upon the brick work. Now since this sewer has stood and maintained its form for several years, the actual pressure exerted by the earth to prevent deformation must be, roughly speaking, somewhere from 1,100 pounds per square foot, at the springing line to 1,400 or 1,500 pounds per square foot at the bottom. If the required force were due to the active pressure of the earth, it could not, by Table 1, exceed from 375 to 840 pounds per square foot, depending whether the earth would stand on a natural slope of 1:1 or 2:1, as the horizontal fluid pressure of earth having a 1:1 slope is only 17 pounds per cubic foot and 38 pounds per cubic foot if the earth takes an angle of 2:1, the total depth from the surface to the bottom of the sewer being 22 feet. As the pressure required is greatly in excess of either of these amounts it is evident that the active pressure of the earth is not sufficient to hold the sewer in shape. The earth, therefore, must act as a foundation in which its resisting qualities are exerted.

By Table 1, the ultimate possible resisting power of the earth horizontally when of material sloping 2:1, and at a depth of 20 feet to the springing line of the sewer is 312x20=6,240 pounds per square foot. If now we assume a required factor of safety, or perhaps better named factor of uncertainty, of 5, the allowable pressure would be about 1,200 pounds per square foot, or about the pressure which probably actually exists. It is thus seen that the sewer must retain its proper form if the brick

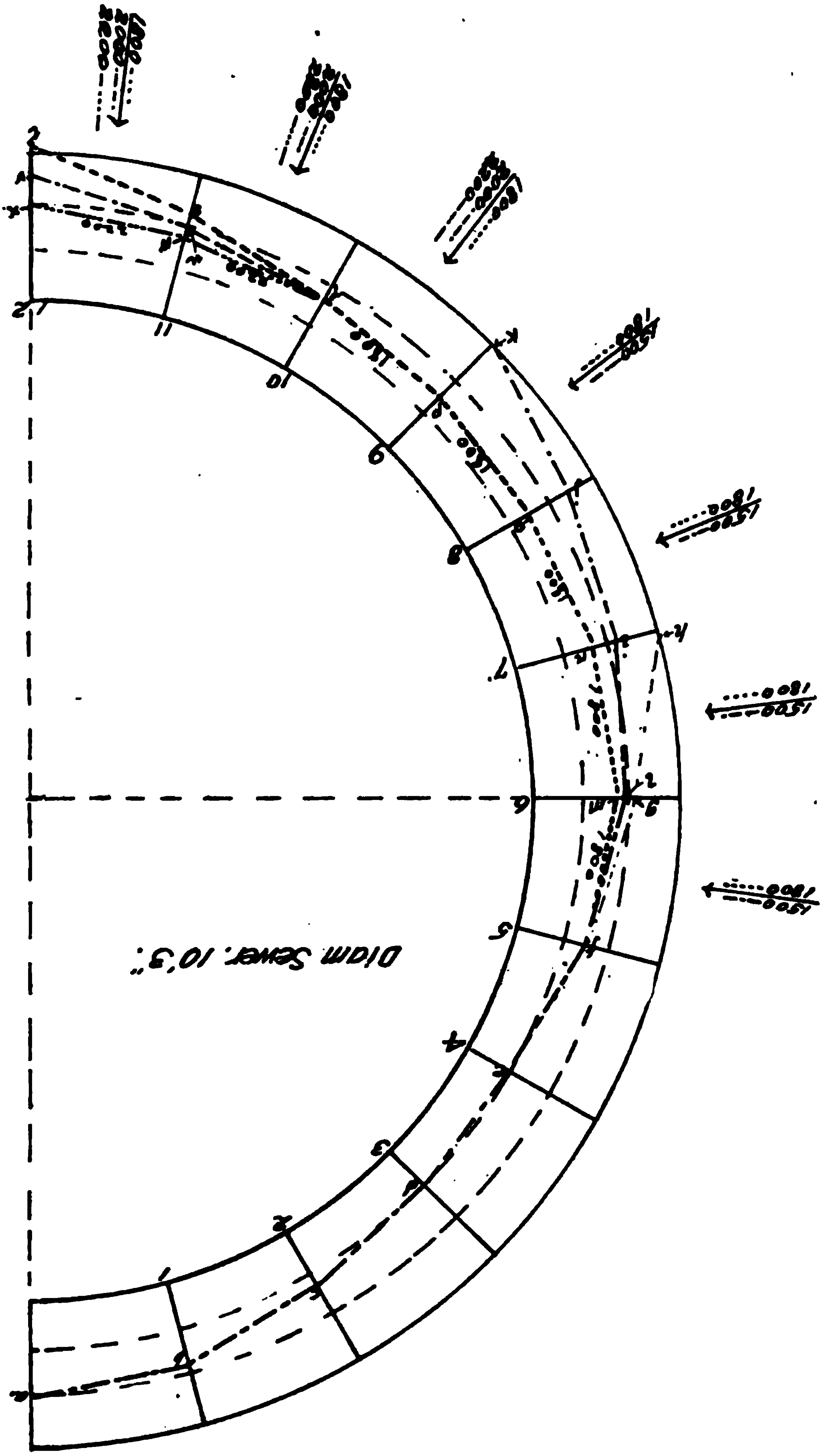


FIGURE 3.

do not actually crush from the pressure. In all the above calculations, the sewer is supposed to be empty, as the additional resistance required by the pressure of the water would not be material in so small a sewer.

As a second example, take the case of a large circular sewer 10′ 3″ in diameter, 4 rings of brick thick and covered with 3 feet of earth over the top of the sewer. The sewer is also supposed to be full of water.

Using, as before, an initial vertical earth pressure of 100 pounds per cubic foot and horizontal pressure 16 pounds per cubic foot, equivalent fluid pressure, joint 3 is found to be the joint of rupture. Beginning, therefore, with a calculated crown thrust of 1,460 pounds, applied at the crown horizontally and at the upper limit of the middle third, the line of resistance shown by broken line is constructed to joint 5. Had the same process been continued to joint 6, the line would have crossed near the outer edge of the joint, and continuing to joint 7, would have passed entirely out of the ring at h, Fig 3.

It therefore becomes necessary to suppose a radial pressure of the earth in excess of that assumed. In order to retain the line within the ring four cases have been considered:

1. Assume radial pressure of 1,500 pounds applied to each of the segments below joint 5. The resulting line of resistance would follow the line f, l, i, j, k, Fig. 3, and pass out of the brick work at k. Evidently, then, the pressure exceeds 1,500 pounds to each segment.

2. Assume 1,800 pounds applied to each segment below joint 5. The line now takes the course f, m, n, o, p, r, s, t, and passes out of the ring at t. This amount is therefore insufficient to retain the sewer in form.

3. Assume 1,800 pounds radial pressure applied to all the segments between joints 5 and 9, and 2,000 pounds to those below joint 9. Now the line of resistance follows the course f, m, n, o, p, r, u, v and does not pass out of the brick work at the bottom of the sewer.

4. Assuming that it is necessary to keep the line of resistance within the middle third, suppose 1,800 pounds to be applied

radially to each of the segments between joints 5 and 9, and 2,200 pounds to each segment below joint 9. The line of resistance now takes the path f, m, n, o, p, r w, x, and remains entirely within the middle third for the whole sewer.

By this investigation two things are apparent: First, that the outward thrust horizontally against the earth at the springing line is less than the downward thrust at the bottom. Second, that if the material in which the sewer is built is capable of withstanding a pressure horizontally at the springing line of 1,800 pounds to each segment or about 1,000 pounds per square foot, and increasing to about 2,200 pounds to the segment or 1,260 pounds per square foot downward at the bottom of the sewer, the sewer will be retained in its circular form without any additional masonry support below the springing line, providing the earth in this region has not been disturbed.

A third conclusion while based entirely on theory is probably true and seems to accord with observed settlements of circular sewers, viz: Comparing results given in columns 6 and 8 of Table 1, it will be seen that the supporting power of ordinary earth to vertical loads is about twice that which it is capable of resisting horizontally. By results obtained from the two cases of sewers investigated, the required supporting power of the earth to maintain a sewer against vertical settlement is only from 10 to 25 per cent. greater than that required to prevent its spreading laterally. It is thus apparent that a sewer is much more liable to spread laterally than to settle vertically. The same effect being observed in both large and small sewers is probably true also for other sizes.

Owing to the complete lack of direct experiment upon the supporting power of the various earths to horizontal pressure there seems to be no data available for either proving or disproving the correctness of the formula for horizontal resistance (formula 3). All the direct experiments available relate to the supporting power of the earth to vertical loads. Here we get some light, but on account of its being a matter of guess work to fix a value for the vertical slope (B) for the earth stratum in question, since its angle of repose would probably be changed were it removed

and submitted to weathering, it is generally as safe to assume directly a value for its supporting power as to assume an uncertain value for the natural slope and then calculate the supporting power by a formula based entirely upon frictional resistance.

The presence of water in large quantities is known to reduce greatly the frictional resistance of earth. Very wet sand, especially if fine sand, makes one of the worst foundations, yet if the water is drained off and if the sand is confined, considerable stability is secured. It is therefore probable that a material which if exposed to weather would stand on a slope of 1½:1 or 2:1, when rendered semi-fluid by large quantities of water, would have a frictional stability of 4:1 or even less. Hence the difficulties of fixing values for the constants of the formula seem practically insurmountable.

In many cases, however, the results so calculated are found to be not bad approximations, and it is probable that the more unstable or the more nearly fluid the foundation material, the more trustworthy the results by formulas 4 and 5 will become. The formulas make the supporting power a direct function of the depth below the surface. It is doubtful if this is the truth, as all tests on the supporting power of earth foundations either neglect the depth at which the test is applied or only consider it a matter of secondary importance. Owing to the complexity of the question, the custom of engineers therefore is to ignore theoretical considerations and to depend entirely upon direct experimental results.

From the foregoing discussion the following general conclusions seem to be justified:

1. That earth presses vertically downward with its full weight, but that in cases where settlement of the structure can occur, a portion of this weight is sustained by the adjoining earth.

2. The deeper below the surface in terms of the width of the excavation, the greater will be the proportion of the vertical weight thus distributed. So that in cases where the depth is several times the width of the excavation, the actual weight sustained may be only that of the earth lying below a rather pointed

arch over the structure and whose span is the width of the excavation.

3. When the structure is at such a depth that conclusion 2 applies, the pressure actually sustained may be expected to increase with the lapse of time and finally may nearly or quite equal the full weight of the super-incumbent earth.

4. The proportion that the actual ultimate pressure is of the full weight, depends upon the nature of the material, being greater with clay and fine sand, especially if wet, and less with coarse sand, gravel, shingle, etc.

5. The rate of increase of pressure towards its ultimate pressure is greater with clay and sand than with gravel or other non-cohesive material.

6. The initial pressure of sand and gravel is greater than that of clay, providing the clay is not saturated with water.

7. The presence of water not only makes the increase in the pressure of the earth more rapid, but causes it to press ultimately with more nearly its full weight.

8. The effects of water upon the pressure of clays and very fine sands is much more powerful than upon the coarser sands and gravels.

9. The active horizontal thrust of freshly deposited earth may be only one-third to one-half of the theoretical pressure, but settlement causes an increase in the pressure, and it is not usually safe to assume less than the ultimate theoretical pressure.

10. Conclusions 5, 6, 7 and 8 apply with the same force for horizontal pressure that they do to vertical pressure.

11. Practically nothing definite is known respecting the abutting or resisting power of earth to horizontal pressure, but for ordinary materials it is probably about one-half its resistance to pressure vertically downward.

12. Theory is of almost no aid in determining the supporting power of earth to vertical loads. Recourse here must be had to direct experiments in each individual case.

13. The softer the material or the more nearly fluid it becomes, the more valuable is the formula for supporting power. Hence in cases of extremely bad foundations theory may be used

as a guide and interpreter of direct experiments, but must not replace them.

14. As the pressure of water increases the active pressure of earth, so its presence decreases the stability or power of earth to resist pressure.

15. Great caution in general is required in the application of all theoretical formulas for earth pressure, in order that the proper conditions may be assumed; and their chief value is their use as a check upon direct experiment and experience.

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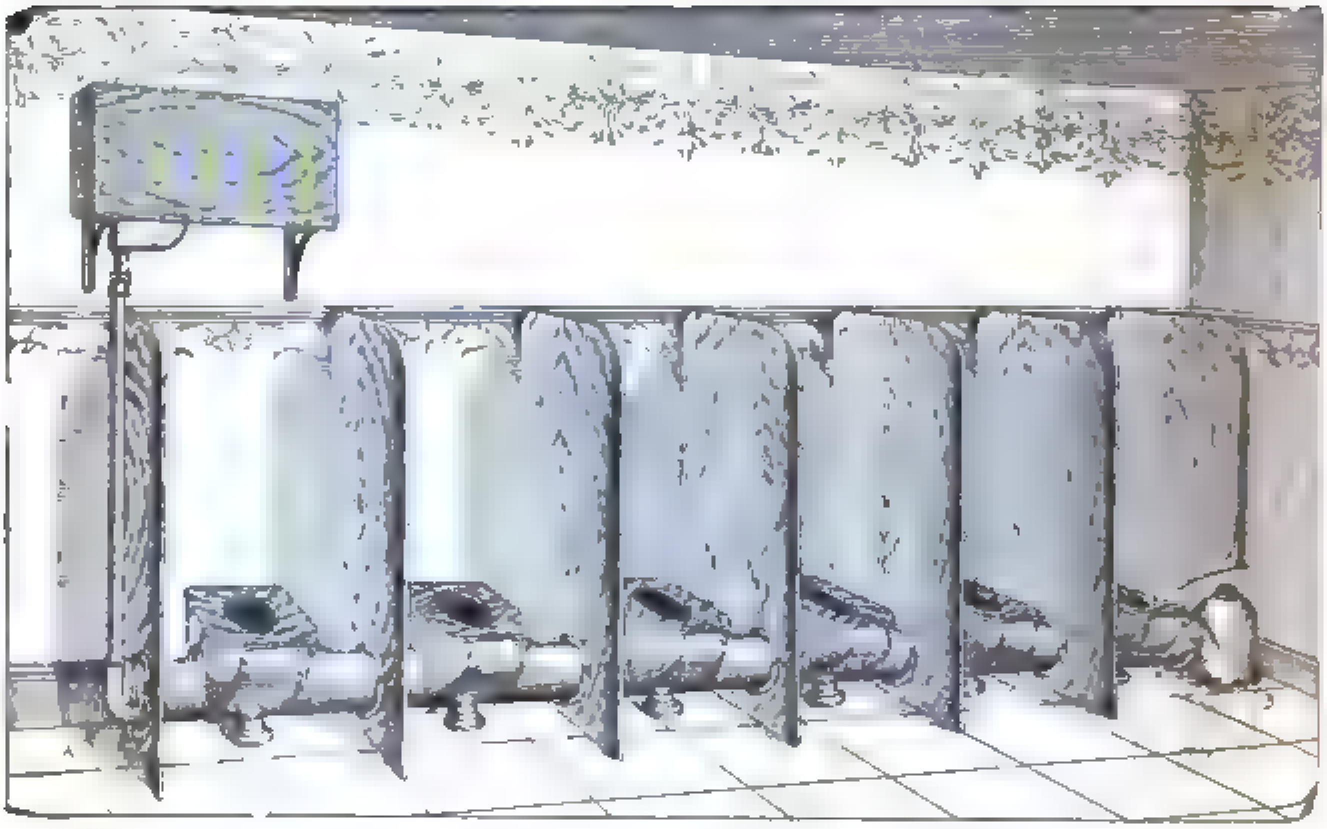

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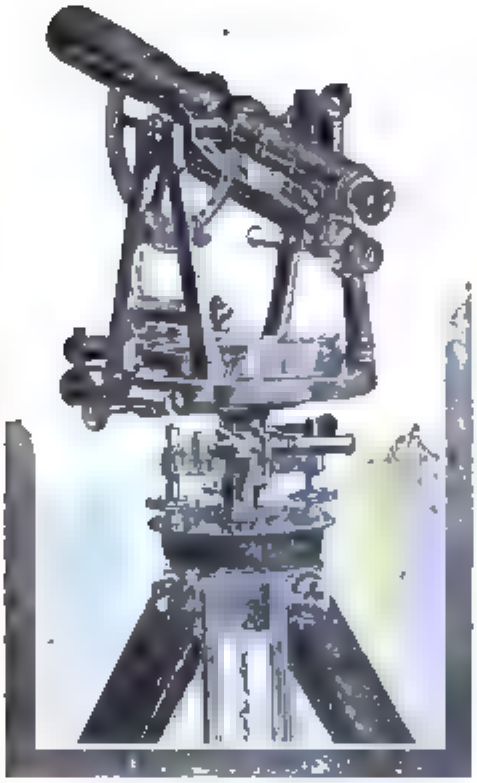

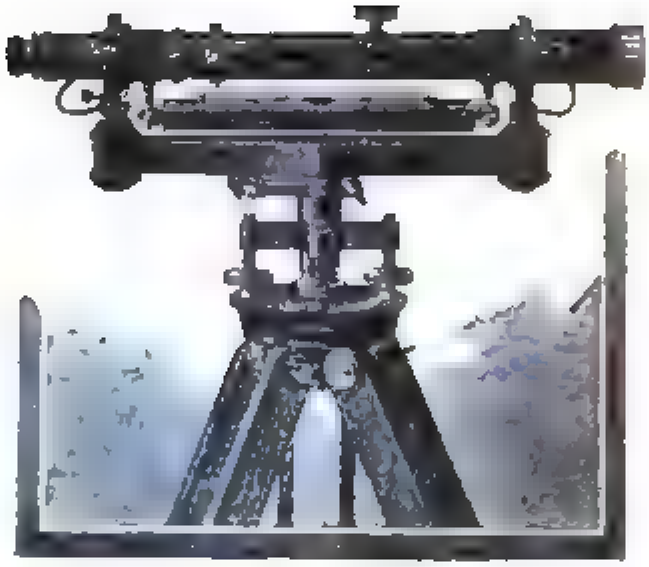

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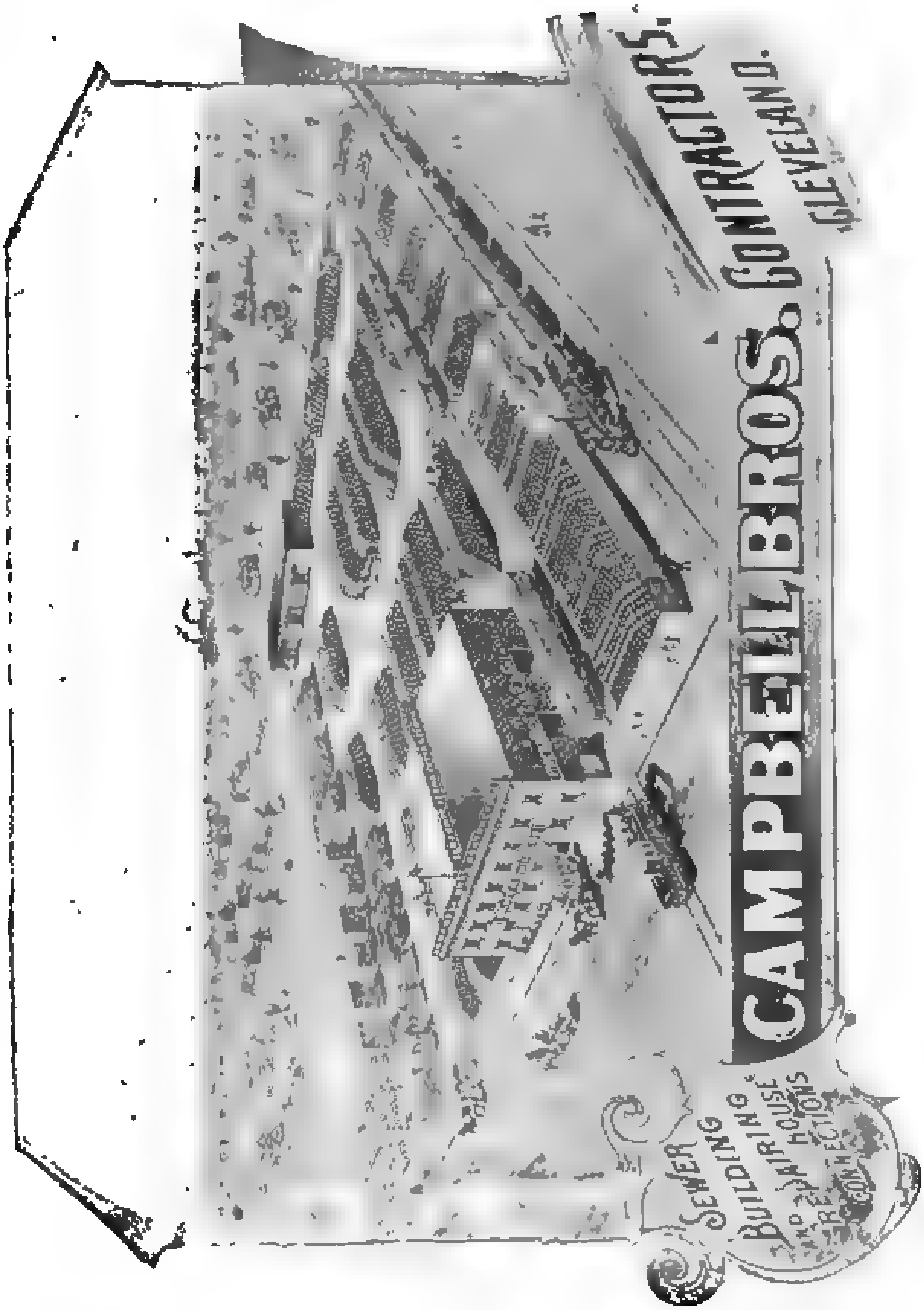

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ANNUAL REPORTS

OF THE

OHIO SOCIETY

OF

Surveyors and Civil Engineers

BEING THE

Transactions of the Society

AT ITS

NINETEENTH AND TWENTIETH ANNUAL MEETINGS

HELD IN

Columbus, O., January 17, 18 and 19, 1898

Cincinnati, O., January 18, 19 and 20, 1899

PRICE 75 CENTS

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NINETEENTH ANNUAL REPORT

OF THE

Ohio Society of Surveyors and Civil Engineers

MEETINGS HELD

In the Y. M. C. A. Building, Columbus, O.

OUTLINE OF PROCEEDINGS

Monday, January 17, 1898.

EVENING SESSION.

The Society was called to order at 7 p. m. by President Innis.

The annual report of the Secretary was presented and upon motion was received and ordered filed.

The annual report of the Treasurer was presented and upon motion was referred to the Trustees for examination.

The reports of the Committees on Legislation and Highway Engineering were postponed until the Chairmen of those committees arrived.

The Secretary stated that he had five applications for membership that should be acted upon at once. Upon motion, a committee of three were appointed by the Chair to examine and report upon the names presented. Messrs. E. A. Kemmier, H. C. White and J. H. Atkinson were appointed.

The Secretary read a paper on "Improvement of Country Roads," by Mr. J. F. Brown, of Cleveland, who could not be present. The paper was followed by a general discussion of the subject.

A motion was made and carried that a committee be appointed to invite Senator Dodge to attend the meetings of the Society and to address the Society upon the road question.

The president appointed Messrs. J. M. Harper, B. F. Bowen and H. M. Gates to wait upon Senator Dodge.

The Committee appointed to report upon the applications reported the following as being recommended for election to membership.

Upon motion the rules were suspended and the Secretary was instructed to cast the ballot of the Society for the following persons:

G. W. Cantrell, South Brooklyn, Cuyahoga county; L. B. Fraker, Bowling Green, Ohio; C. M. Gordon, Georgetown; E. P. Dickey, Pittston, Luzerne county, Pa.; W. Alderdice, Warren, Trumbull county.

On motion, meeting adjourned until Tuesday morning.

Tuesday, January 18, 1898.

MORNING SESSION.

President Innis in the chair.

Neither of the gentlemen named in the morning program having arrived at the time of opening the session, it was suggested that impromptu remarks would be in order. Mr. Stump was called upon and renewed the discussion of the subject of "Roads."

Mr. H. J. Lewis, Chairman of the Committee on Bridge Engineering, had sent his report to the Secretary, who read it to the Society.

The following papers were read and discussed: "Random Notes on the Construction of Brick Pavements," by E. A. Kemmler; "Highway Improvements with a Sketch of Recent Practice in Green County," by G. A. McKay; and "The Legislature and the Roads," by J. A. Hanlon.

The committee appointed to invite Senator Dodge to address the Society reported that they had called upon the Senator and that he would speak to the Society upon the subject of "Roads" at this evening's session.

Upon motion the report was accepted and the committee was discharged.

On motion the meeting adjourned.

AFTERNOON SESSION.

The report of C. F. Abernethy, Chairman of Committee on Land Surveying, was read by J. T. Buck, a member of the committee.

Mr. Buck also presented a supplementary report. A problem in Land Surveying was submitted to the Society by Mr. G. H. Hill.

The reports and problem were fully disucssed.

Mr. J. B. Davis' paper on "Some New Features of an Improved Solar Transit," was read by Mr. Ulmer.

Mr. Hosea Paul's paper on "Field and Office Records," was read by the Secretary.

The President appointed the following committee on nominations, with instructions to report Wednesday afternoon: Messrs. H. C. White, B. F. Bowen, J. T. Buck, J. W. Stump and J. M. Harper.

As there were only two members of the Board of Trustees present, it was moved and carried that the President appoint three members to fill the vacancies. The president appointed Messrs. W. B. Gerrish, J. B. Weddell and G. A. McKay.

The Secretary read a letter from William B. Melish, President of The Cincinnati League, inviting the Society to hold its next annual meeting in Cincinnati.

On motion adjourned until 7 p. m.

EVENING SESSION.

President Innis being absent on account of ill health, Mr. J. B. Weddell was chosen to preside during the evening.

Senator Martin Dodge was introduced and addressed the Society upon the subject of "Road Improvements."

A unanimous rising vote of thanks was tendered Senator Dodge for his very able address.

Paper on "Concrete Arches," by Mr. W. H. Pratt was read and discussed.

The New Columbus Bridge Co. extended an invitation to all members of the Society to visit their bridge shops at any time.

The Secretary read a letter from G. H. Stewart, President of the Board of Trade of Columbus, inviting the society to hold its next annual meeting in Columbus.

On motion adjourned.

Wednesday, January 19, 1898.

MORNING SESSION.

President Innis in the chair.

The following papers were read and discussed: "Sewer Construction," by J. B. Weddell, and "Chemical Treatment of Sewage at Alliance," by O. W. Pfouts.

Upon motion the meeting adjourned.

AFTERNOON SESSION.

President Innis presiding.

Mr. E. S. Ault could not be present, but had sent his paper on "Sewer Construction in Marion, O.," which was read by the Secretary.

Mr. H. L. Weber read his paper on "Some Actual Bridges, Past and Present."

Mr. Weber also read a report on the "Garbage Plant of Richmond, Ind."

Mr. M. A. Munn read a paper on "City Franchises and City Streets in Small Cities."

The President's address was read by his daughter, Mrs. Bohannon.

The report of the Committee on Water Supply was presented by J. B. Strawn, Chairman.

A paper entitled "The Water Works and Filter Plant of Warren, Ohio," was read by Homer C. White.

The last three papers, all relating to Water Supply, were discussed together.

The Trustees presented their report of their examination of the Treasurer's books and also recommended a list of names for membership, for which see Trustees' Report on following page.

Upon motion the rules were suspended and the Secretary ordered to cast the ballot of the Society for the named applicants. This was done and the same declared duly elected to membership.

The invitations for our meeting next year were taken up and discussed. It was moved and seconded that the invitation extended by Cincinnati be accepted. A ballot being taken, showed a majority in favor of Cincinnati, and it was announced that the 1899 meeting would be held there.

A resolution requesting the appointment of a permanent Highway Commission by the Legislature of Ohio, was presented and unanimously adopted. (Printed on a following page.)

It was moved and carried that a copy of the resolution be sent to Senator Dodge.

The Committee on Nominations reported a list of officers for the ensuing year, which were duly elected by ballot. The list is published on page 2 of this report.

It was moved, seconded and carried, that a committee of three be appointed to co-operate with the Committee of the L. A. W. and help to pass the bill which Senator Dodge may introduce.

The president appointed the following on the above committee: A. W. Jones, Chairman; J. M. Harper and B. F. Bowen.

On motion a vote of thanks was extended to the press of Columbus for the complete and accurate notices of our meetings.

On motion the meeting adjourned.

EVENING SESSION.

President Innis being absent, Vice President Cellarius presided.

Prof. A. A. Wright, of Oberlin, read a paper entitled "How to Secure a Topographical Survey of the State."

After discussion a resolution was adopted endorsing the proposal for co-operation of the production of a Topographical Atlas of Ohio, and the Secretary ordered to transmit a copy of the resolution to the proper committees of the Legislature.

A paper by B. J. Ashley on "Economy of Combining Water Works and Electric Light Plants," was read and discussed.

A vote of thanks was extended the Secretary for the work in connection with his office and for which he receives no compensation.

The new President, Mr. Gilpatrick, was called on for a speech and in response urged the importance of the Society and its work and requested the co-operation of the members.

The Hon. R. M. Haseltine, Secretary of the Ohio Institute of Mining Engineers, invited the members of our Society to attend the meetings and excursion of the Institute, which began their annual meeting on the following day. The invitation was accepted with many thanks.

The following papers were read by title and ordered printed:

Report of Committee on Railroad Engineering.

Report of Committee on Land Drainage.

Report of Committee on Instruments and Exhibits.

"Maintainance of Way on Railways," by John W. Atkinson.

After listening to a short concert furnished by Mr. D. N. Osyor by means of his graphophone with "Echo" improvement, which was much enjoyed by the audience, the Nineteenth Annual Meeting was adjourned.

REPORT OF SECRETARY.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—I have the honor of submitting the following as the annual report of the Secretary for the year ending January 15, 1898:

The roll of membership is made up as follows:

Honorary Members	5
Active Members	127
Associate Members	3
Total	135

The Society is carrying quite a number of persons on the list of active members who are very inactive, to say the least. They take no further interest in the Society or in its work and from one cause or another have practically dropped out.

It seems that something should be done to clear our roll of this dead timber, although we ought to be slow in dropping any one who wishes to be identified with us and who has not felt able to meet the Society dues during the last few years. For some years these were rather high and many felt that the dues, together with the expense of attending the annual meeting, made the membership rather an expensive luxury, which the general business depression did not permit.

A strong effort should be made during the coming year to induce those who have fallen behind to reinstate themselves in good standing, and if they do not the provisions of the Constitution should be enforced.

The usual exchanges have been made and have been or soon will be distributed to the members who have paid their dues.

Our own report was sent out to all members whether dues were paid or not.

The Secretary has had letters from several surveyors and engineers asking about laws regulating the practice of surveying. It seems that there is a little interest being developed in this old question that our Society has discussed so often. At the last meeting the present Committee on Legislation was requested to present at this meeting a draft of a bill on the licensing of Surveyors.

It seems as though a bill of this kind ought to be passed, now that a number of similar ones relating to other professions have been enacted by the legislature.

The Secretary wishes to thank the many members who have aided him in various ways in the preparation of the last report and with the program to be presented at this meeting. He also wishes to offer as an excuse for any lack of attention given the Society work the fact that he was out of the city much of the summer and has been very busy with college work this past fall.

Very respectfully submitted, C. N. BROWN, Secretary.

REPORT OF TREASURER.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—I have the honor of submitting the following report of the receipts and expenditures of the Society for the "Society year" 1897, from January 15, 1897, to January 15, 1898:

RECEIPTS.

Balance on hand from 1896	$ 42 97	
Advertisements in Seventeenth Report, 1896	12 50	
Advertisements in Eighteenth Report, 1897	288 00	
Sale of Reports	10 50	
Dues for 1895	15 00	
Dues for 1896	40 00	
Dues for 1897	155 00	
Membership fees	14 00	
Advanced on dues for 1898	7 00	$584 97

EXPENDITURES.

Final payment on printing Sixteenth Report	$ 66 05	
Paid on account of printing Eighteenth Report	315 00	
Stenographer for Eighteenth meeting	57 00	
Postage	63 00	
Clerical help	47 00	
Stationery, circulars, programs and other minor printing	20 10	
Express, freight and hauling	3 25	
Office supplies	4 72	
Signs for eighteenth meeting	2 50	$578 62
Cash balance on hand		$6 35

UNPAID BILLS.

Balance on printing the Eighteenth Report	$17 97
Rent of hall for Eighteenth meeting	12 00
Stationery	3 80
Total	$33 77

MONEY DUE THE SOCIETY.

Advertisements in the Eighteenth Report	$50 00
Back dues, estimated at not less than	30 00
Total	$80 00

Of the money due the Society all that due for advertisements can be collected without trouble or loss. This will put the Society entirely out of debt. If we had not had to pay the remainder of $66.05 on the 1896 Report we would have had a very nice little balance left over this year.

Very respectfully submitted,

C. N. BROWN, Treasurer.

REPORT OF TRUSTEES.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—The undersigned Trustees of your Society for the year 1897-98 have, in accordance with the constitution, duly examined the books of the Secretary-Treasurer and find the accounts correct, and that proper vouchers for money paid out have been shown.

The Trustees recommend the following persons for membership: William Wilson, L. B. Harvey, Allen E. Bretz, E. C. Loofborrow, C. E. Sherman, Otho Fields and W. H. Pratt.

J. B. STRAWN.
W. B. GERRISH.
J. B. WEDDELL.
G. A. McKAY.
J. L. GILPATRICK.

RESOLUTION ENDORSING A PERMANENT HIGHWAY COMMISSION

Resolved, By the Ohio Society of Civil Engineers and Surveyors, in convention assembled, that the Legislature of Ohio be requested to provide by law for the appointment of a Permanent Highway Commission to continue the work of the temporary commission heretofore appointed, and to forward the cause of road improvement in the state.

Resolved, That the report of the temporary commission, heretofore made and published, is of such value and in such demand that ten thousand additional copies should be published by the state.

And Resolved Further, That Senator Martin Dodge, of Cuyahoga county, who has long been a firm and constant advocate of highway improvement, be requested to prepare and introduce a bill which shall authorize the appointment by the Governor of four suitable persons to act in the capacity of Highway Commissioners.

Adopted unanimously.

RESOLUTION ENDORSING TOPOGRAPHICAL SURVEY OF OHIO.

Resolved, By the Ohio Society of Surveyors and Civil Engineers, that we endorse most heartily the proposal for co-operation on the part of Ohio with the United States Geological Survey for the production of a Topographical atlas of this state.

We believe that it will benefit every locality in the state and will minister to business interests as well as to the cause of education and science.

We believe that Ohio ought not to be behind the other states that have secured their topographical maps in this way.

We pray our legislature to enter upon this work at once and complete it as rapidly as may be practicable.

Adopted unanimously.

PRESIDENT'S ANNUAL ADDRESS.

G. S. INNIS, COLUMBUS, OHIO.

Gentlemen of the Ohio Society of Surveyors and Civil Engineers:

Another year has passed in the life of our Society without the thinning, to my knowledge, of our ranks by death.

It is proposed as preliminary to my address to give you a description of a young man who would be likely to make a good civil engineer. I should choose one of good judgment for his age, endowed by nature with good common sense in every direction, whose morals must be above reproach and he himself must have the most invincible integrity. A civil engineer generally has to decide between parties to a contract, so must not be moved by any consideration other than strict justice between the parties. If a civil engineer is heard asking a contractor for money, more or less, for beer or other intoxicating liquors, watch him. The chances are there are better men in the penitentiary than he. He must be educated from the ground up, a good speller, an excellent English grammarian, good in arithmetic, algebra, geometry and, in fact, all the higher mathematics. This will prepare him to enter a course of Surveying and Civil Engineering in any college or even our State University, where Professor Brown will instruct him how to finish the course. I am sure our worthy Secretary would be exceedingly well pleased to know that each one of his students fully realized the purpose for which his friends sent him to school.

Those students who attend from their own volition and pay their own way out of their personal earnings, generally realize fully that their object is to acquire all the knowledge they can obtain during their college days. Faithful persons who study as constantly as good health permits and go to the bottom of things will, nearly without exception, leave the university good scholars. Such as these make life students and as sure as they live become eminent in their chosen profession, and finally leave this world of ours very much the better for having lived in it. The genius among this class of students, if he lives to the age allotted to man, is sure to become a distinguished citizen; perhaps becomes immortal by reason of some great good he has done mankind.

Now gentlemen, with your permission I propose in this paper to relate to you the present condition of the water supply system of our city of Columbus. This will doubtless contain more or less errors or inaccuracies, as it is believed no one can be found who thoroughly understands a system of water supply. In fact, the so-called scientific system that will apply to several different localities has yet

to be found or written. In any science depending on experiments for its proofs, mistakes will be hereafter discovered. We may well join with my old professor of mathematics, when hearing the class lessons on mathematical astronomy, in saying, "I wish the author had told us what he knew and then let us help him guess at the remainder." But mankind still keeps guessing and probably will continue so to do until the end of time. Our greatest need is a river constantly flowing, with its banks so filled with water as to make the flow so large that the river will furnish a constant and plentiful supply of good water at all times for all city purposes. The Scioto river is the best source of supply Columbus has when quantity is taken into consideration. The Alum creek supply is very good water, but it lacks in quantity for the entire city. Columbus and the high lands of the county of Franklin are visited about once in a generation with a very severe drouth. The last one we had was in the year 1895, the one before that occurred in 1838. This was particularly severe. The farmers of whole neighborhoods were compelled to take their stock to the nearest stream for water. For household use it was hauled in barrels. This taking the stock to water we boys thought a hard job. Still we had some consolation in it, as we were informed by a man of purely Puritan descent, named Waterford, that in New England, where he came from, he had to drive his father's cattle twice each day twenty miles to water, and pay ferriage over two rivers! For over a score of years, after hearing this story, if any one told an improbable tale, he was at once asked if his name was not Waterford.

The watershed of the Scioto has an area of about one thousand, or perhaps eleven hundred, square miles—about forty or forty-four townships of five miles square each. This would tend to show that the river would furnish an ample supply in each year for a city of five hundred thousand people if the water could only be saved for us at the time of our severest drouth. There have been a number of suggestions for this purpose. One is to build a dam thirty feet high across the Scioto, up some miles above Columbus, where the channel is narrow and the banks steep and formed of stratified limestone.

The most serious question is, would such a dam be safe. Another proposition has been suggested to build a series of these dams up the river ten feet high; say, put in three or four now, or as many as we may need. Then let our grandchildren and the future inhabitants of the city increase these dams to any number necessary for their use. These low dams would certainly be safer than one high one.

The next question that presents itself is as to the quality of the water furnished by the Scioto. This is the most unfortunate feature connected with the supply from the Scioto river. This river rises in a bog large enough in area to make several townships. This bog was in early times the most celebrated pigeon roost in the state, as well as the resort of many wild animals. These, with the natural growth of grass and other vegetable matter, have made a very rich soil

from two to four feet deep; in fact, in many places a surveyor's pole can be easily pushed into the soil from six to ten feet. Water that has soaked through this soil is certainly not a desirable drink.

A little further down the river we find the town of Kenton, having seven or eight thousand inhabitants, pouring her sewage into the Scioto river; then comes Marysville, a town about one half the size of Kenton, doing the same thing; then the city of Marion, about fifteen thousand inhabitants, with its sewage. The Girl's Industrial Home and the town of Dublin empty their sewage into the river. Then below its source the river runs between banks of soft yellow clay, which readily mixes with the water and gives it that yellow tint so frequently seen in our hydrants. The Scioto, for a considerable portion of the distance from its source to the city, is lined on one or both sides with very rich alluvial bottom lands. The drainage from these lands, with all its impurities, empties into the river.

Columbus has other sources of supply, the most important of which is the aqueduct under the Olentangy and Scioto, extending up the south side of the latter. This aqueduct might be prolonged indefinitely. At other places the underground supply can be largely increased. For instance, when putting in the West Side sewer a contractor said three places were found where it took from six to eight steam pumps to keep the water out sufficiently to allow the workmen to construct the sewer. At one place he gave it as his opinion that there was quite an underground stream of water. An underground stream was found when the workmen were sinking the artesian well in the State House yard. It was several hundred feet below the surface and the workman told me the water was twenty feet deep and, as he believed, had a rapid motion, from the fact he could put his tools down very muddy and after a little time draw them up and they would be clean. This same underground stream was found by Kilbourne and Jacobs when they were drilling for gas at or near their scraper factory. At the northwest corner of Woodward avenue and Fourth street there is a flowing well of most excellent water which, in my opinion, might be largely increased. At the starch works of J. J. Wood & Co. there were four or more flowing wells found at one hundred and thirty-seven feet, which furnished an abundant supply of good and pure water for the starch company, although they manufactured fifteen hundred bushels of corn per day into starch.

From the above known facts it would seem there is scarcely any limit to the water supply of the city. All we need is to make the proper experiment to find that supply.

REPORT OF THE COMMITTEE ON WATER SUPPLY.

J. B. STRAWN, SALEM, OHIO.

The first public water supply introduced in this country was that for Boston, Mass., in 1652. One hundred years later water works were built at Bethlehem, Pa. The next was at Providence, R. I., 1772. New York in 1799. At the close of 1800 there were but sixteen public water supplies in the United States; and all of these were built and owned by private capitalists. At present all of the eighteenth century water works, excepting three, are owned by the cities. From 1800 to 1820, fifteen more supplies were added. Up to 1850 there were, all told, but eighty-seven public water supply works. In 1875 the number had increased to 189. In the next five years, viz., 1875-1880, 188 works were built, as many, lacking one, as had been built between 1652 and 1875, or in 223 years from the time the Boston works were built. The next five years, 1800-1885, there were 431 water supply systems built. From 1885 to 1890 there were 898 systems built; and from 1890 to 1896, inclusive, there were built in the United States no less than 1483 new water supply systems. What the showing will be in 1900 cannot be foretold. It is questionable whether all the rest of Christendom can show a like number of public water supplies for the same period. The present outlook justifies the belief that in the United States in the very near future no town or village of 500 souls will be without a public water supply.

The influence of a bountiful supply of wholesome, potable water upon the health and life of people is incalulable. Sanitarians and specialists have spent much time investigating water supplies, with a view to determining the exact requirements for an ideal standard for potable water. Supplies that once were pure and delicious, are now so contaminated as to be no longer fit for domestic uses. The first water supplies were introduced at a time when most of the sources were clean and uncontaminated. But now, many of our once fair lakes, rivers and brooks, instead of furnishing pure, delicious water, are becoming very harbingers of death.

The causes for all of these changes are not difficult to understand. As the country became settled up with a multiplying population, which in large part were drawn to centers to engage in commerce, manufacture and various enterprises and trade, the town sites were generally selected along the coast, or upon the margins of our lakes or banks of our rivers. In all large centers of population will be found many requirements not essentially necessary for a rural population. Man's freedom is restricted, his liberties are abridged in numerous ways. He

no longer is the free and independent rover who can do as he chooses, and is a law unto himself. He must yield up certain of his liberties, and in turn his new requirements must be met. He now is a citizen, a modern citizen. But, with all, he has inherited a certain amount of barbarism which has, in some respects, been modified; but there is one characteristic in humanity, while not universal, is so general that I think we must class it as an original sin; and that is the tendency, where any filth, garbage, human waste, or any other nuisance must be gotten rid of, his plan is to convey it to the nearest water course and dump it in. It matters not to him whether it be a stream used for public water supply, or in the slimy pool where the swine luxuriates. The consequences are never considered. He is oblivious to the fact that an enlightened community demands a clean, potable water for man's bodily requirements and for domestic uses; while the town must have water, not only for domestic purposes, but for divers other uses, and this must be ample for emergencies as well as for ordinary uses, with a generous margin for future growth of population or other unforeseen contingencies.

The supply must not only be free from contamination, but its environment should be such as to guarantee continued purity to the supply. Right here is where the conflict arises. The semi-barbarian will persist in defiling the streams, lakes and rivers, and, in not a few instances, our far-famed springs which have been a source of life and joy to the rustic as well as to the sage, or millionaire, or pleasure-seeker, have been so far contaminated as to be no longer safe. Sewage has found an entrance through pervious soils and rock crevices, and the waters are poisoned and the red placard of danger now again tells the story of man's inhumanity to man.

In the city of Salem one of those delightful springs for two generations was the pride of the place. At the time the city granted a franchise to the Salem Water company, one of the stipulations was that this spring water must be used, or water equally good, for the city supply. Would you look upon the scene now, where the spring sent forth its cool, sparkling water fifty years ago? There stands over the site now a small pumping station; three drilled wells were put down to secure additional water, which not only drained the spring, but almost 100 wells in the neighborhood of the spring; for the city now is quite closely built up for a distance of nearly half a mile beyond, on rising ground. A large, flowing well some distance from this pumping station, at the old spring, was also drained on sinking the wells above mentioned. Some of the wells drained are now reported to be used as receptacles for garbage and even cesspools. Certainly one conclusion seems evident, and that is this: whatever foreign matters are received into these drained wells must find their way into the city water supply. While the entire supply is not derived from the drilled wells, probably one half is taken from springs some distance away, and an artesian well at the principal pumping station.

The question very naturally suggests itself: Has Salem ever been afflicted with typhoid fever since the present city water supply was introduced?

Note—Since typhoid fever is, by common consent among specialists, taken as the disease most notably prevalent where a polluted water supply is furnished, and, again, from its general absence where a clean, pure supply is furnished, the writer will endeavor to follow the course in this paper.

Geographically and topographically, Salem occupies an ideal location. Its elevation above sea level is just right. The site is entirely free from malaria, the natural drainage is exceptionally good. It occupies a watershed, where the drainage is parted by a summit running through the city; in fact, the physical environment of Salem is beyond criticism. With all these, Salem has maintained a death-rate from typhoid fever for the past eight years, or since the introduction of the present water supply, that is abnormally high. Something is wrong—"dead wrong." The records of the health officer show that in 1890 there were 64 cases of typhoid fever; in 1891, there were 59 cases; in 1892, 38 cases; 1893, 111 cases; 1894, 103 cases; 1895, 30 cases; 1896, 19 cases, and 1897, to November, 58 cases; making a total of 482 cases in eight years, being an average of more than 60 cases per year, with an annual death rate of 10.3 per 10,000 of population. The population of Salem is about 8000. The average death rate from typhoid fever in Ohio for 1894 was 5.1 per 10,000 of population, and 1895 was 5.5 per 10,000 of population, and for 1896 was 4.4 per 10,000 of living population. The death rate from typhoid fever for 32 largest cities in Massachusetts for 1896 averaged 2.9 per 10,000 of living population, only a trifle over half the mortality from typhoid fever that Ohio had in 1894 and 1895. The average death rate from typhoid fever in Massachusetts for the state, for 25 years,1871-1896, was 3.2 per 10,000 of living population. It would be of interest to carry the comparison further, but for the present report, it will be out of place to carry out any extended details or to multiply examples to a considerable length. A few must suffice. Our comparisons will be best shown by the results obtained in the largest cities of Europe. The student of water supply fully realizes that the oldest and most densely populated countries, without efficient sanitary measures, have a polluted water supply, if it be taken from rivers or surface drainage. Many of the oldest cities of Europe, as far back as 40 or 50 years ago, began to realize the extent of mortality from polluted water. London was for many generations supplied with raw water from the Thames and Lea rivers. Vienna formerly used water from the Danube river. The deaths from typhoid fever ranged from 100 to 340 per 100,000 of population up to 1874, when a spring water supply was introduced; when the death rate fell to 11 in 100,000, or 1.1 in 10,000 of living population.

RECORD OF TYPHOID FEVER IN EUROPEAN CITIES.

CITY.	Population.	Death Rate from Typhoid per 10,000 Living Population.	Water Supply.
London	4,356,411	1.7	Filtered Thames and Lea river water, about 1-6 well water.
Paris	2,424,705	2.5	Springs and Artesian wells.
Berlin	1,714,938	0.9	Filtered river water.
Vienna	1,435,931	0.7	Spring water, formerly Danube riv.
Hamburg	634,878	1.8	Filtered river water.
Glasgow...........	667,883	2.0	Loch Katrine.
Amsterdam	437,892	1.6	Filtered dune water.
Breslau	353,551	1.1	Filtered river water.
Dresden	308,930	0.5	Ground water.
Rotterdam	222,233	0.5	Filtered river water.
Hague	169,828	0.2	Filtered dune water.
Average	1,157,016	1.2	Per 10,000 of living population.

In the above list Paris has the highest, being 2.5 per 10,000, while Hague has the lowest, being 0.2 per 10,000, or only 3 deaths in 1893, with a population of 169,828.

DEATH RATE FROM TYPHOID FEVER IN AMERICAN CITIES FOR 1893.

CITY.	Population.	from Typhoid Death Rate per 10,000 Living Population.	Water Supply.
New York	1,515,301	2.3	Impounding reservoir.
Philadelphia	1,046,964	7.4	River water.
Chicago	1,099,850	7.2	Lake Michigan.
Boston	448,477	3.9	Reservoir.
St. Louis	451,770	3.2	Mississippi river.
Brooklyn	806,343	2.4	Wells, ponds and reservoirs.
New Orleans	242,039	1.9	Cisterns—Mississippi river.
Detroit	205,876	1.9	River.
Milwaukee	204,468	3.0	Lake Michigan.
Baltimore	434,439	4.9	Reservoir.
Cincinnati	296,908	5.1	River.
San Francisco ..	298,997	5.6	Creek, lake and mountain streams.
Buffalo	255,664	3.1	
Cleveland	261,353	6.3	Lake.
Washington	230,392	8.7	Rivers.
Pittsburg	238,617	12.7	Rivers.
16 cities. Av.	502,337	Av.rte 4.97	Four times the rate for European cities cited.

Pittsburg has the highest rate, 12.7 in 10,000. New Orleans and Detroit have the lowest, 1.9 in 10,000. Should we come below 200,000 and over 100,000 for other United States cities for high death rate from typhoid fever, the list would contain Denver, 21.7 per 10,000; Allegheny, 18.2; Newark, N. J., 10.0; Jersey City, 8.2; Louisville, 8.2; St. Paul, 6.9;

Minneapolis, 5.7; Indianapolis, 5.4; Omaha, 4.5; Providence, 4.0; Kansas City, 4.0; Rochester, 3.9. These 12 cities of over 100,000 and under 200,-000, with an average of 135,884, have an average death rate from typhoid fever of 8.4 per 10,000 of living population, and when compared with the 11 European cities shows the death rate of our own cities to be just seven times that of the eleven European cities. Should we drop down and consider the mortality from typhoid fever in our smaller cities and villages, taking water from polluted rivers, and from other sources which are no better, the showing would be still worse. Birmingham with 26,000 population in 1893, had no less than 26.40 deaths to every 10,000, from typhoid. Enough has been given to give a tolerably fair idea of what is, and what may be done. All things taken into the account, Europe has not a better natural water supply than the United States has; nor are their present conditions so favorable as are ours.

Europe waited long and suffered much from polluted waters until scientists and experimenters demonstrated what their trouble really was. Since which time a large number of the great cities are being supplied with exceptionally pure and wholesome water. Most of these cities are reported to be models of cleanliness, and yet their consumption of water per capita will not, perhaps, average one-third what our American cities use per capita. If the use of a vast quantity of water is necessary to cleanliness, which is claimed to be next to Godliness, then we Americans who live in such cities as Chicago and New York should be counted as the elect.

Very properly may it be asked in this connection, How has Europe secured so good a water supply for domestic use? In answer to this question it may be said that where a spring water was not available, and artesian water of a suitable character could not be procured, filtration has been resorted to with the most satisfactory results. The waters of foul, sewage polluted rivers have been filtered on a large scale, using sand filters for large cities as London, Amsterdam, Rotterdam, Hague, Berlin, Hamburg and many other cities of large size.

It would be unwise to even attempt a description of the vast filter-plants for some of these cities. The first filters built were at London in 1839. In 1893, with 116 acres of filter surface, the average daily quantity filtered was 195,000,000 gallons. In his work on "The Purification of Water Supplies," written after an extended tour of large cities in Europe, Mr. Allen Hazen says "Evidence regarding the healthfulness of the filtered river water was collected and examined in a most exhaustive manner, in 1893, by a Royal Commission appointed to consider the water supply of the metropolis in all its aspects with reference to future needs. This commission was unable to obtain any evidence whatever that the water as then supplied was unwholesome or likely to become so."

Statements of like import regarding other cities could be multiplied. It is enough to say that badly polluted waters after filtration as practiced in the European cities cited, become safe potable waters, if judged

by the ordinary standards. "The main point is that disease germs shall not be present in our drinking water." "If they cannot be kept out, we must take them out. Sedimentation and storage may accomplish much, but their action is too slow and often uncertain. Filtration properly carried out removes bacteria promptly and thoroughly and at a reasonable expense."—Hazen.

Sec. 8 of the rules of the German government in regard to the filtration of surface waters for public water supplies reads as follows:

"The best sand filtration requires a liberal area of filter-surface, allowing plenty of reserve, under all local conditions, a moderate rate of filtration adapted to the character of the raw water.

One other rule is given, mainly to show how the German attends to business.

Sec. 16. Every city in the German empire using sand-filtered water, is requested to make a quarterly report of their working results, especially of the bacterial character of the water before and after filtration, to the Imperial Board of Health, which will keep itself in communication with the commission chosen by the water works engineers in regard to these questions; and it is believed that after such statistical information is obtained for a period of about two years, some farther judgment can be reached." A momentous question of vital importance. Is there any reason why our American cities, especially those using polluted river water, should not by using the European practice of filtration, and the same thoroughness, attain the same immunity from typhoid fever and kindred diseases that the most favored cities of Europe enjoy?

In 1891, this Society by a unanimous vote approved a bill prepared by the writer, which bill was afterwards approved by the State Board of Health, and in 1893 was incorporated and became a law when the Ohio laws pertaining to the powers and duties of the State Board of Health were codified. The law referred to is the one which requires the approval by the State Board of Health of all water supplies and sewerage systems before the same shall be introduced. This law has been enforced faithfully under all circumstances. It is one thing to get a fortune, but it is quite a different thing to keep it. So it is a good thing to secure a good wholesome water supply, but that is no guarantee that the supply will remain so. Our state must needs take another step. The powers and duties of our State Board of Health should be extended as regards our water supply. Little or no attention is paid to a water supply after its introduction, until some epidemic, due to a polluted water, has caused much sickness and many deaths; and then, from want of knowledge or judgment the case may fail to have prompt attention. Our annual health reports contain numerous cases of this kind, and when the board is called for consultation, it often takes weeks before they can accomplish anything to relieve the stricken town or city. I firmly believe that there should be a law enacted making our State

Board of Health a special guardian of our inland waters and of all public water supplies especially, with power granted it to analyze water supplies in the state both chemically and bacteriologically. That after such examinations the board shall classify said water supplies as regards purity or other conditions, and that full and accurate records be kept of all such examinations. For the accomplishment of this work, the of said examinations, which examinations shall be of such frequency as in the judgment of the board shall be necessary. That at as early a date as possible the work of public water supplies examination be begun; that all public supplies be examined as many as four times a year or oftener at the discretion of the board. The foregoing is but suggestive.

The National Conference of State Boards of Health, which met in Washington in May, 1891, devoted much time to the dangers threatening public water supplies. At the conclusion of this discussion, it adopted the following: "Resolved, That it is the sense of this conference that the pollution of streams is attaining such magnitude that early action should be taken by state and local boards of health looking to its prevention." In connection to the foregoing, I will present an article from the Ohio Sanitary Bulletin.

WATER SUPPLIES OF OHIO.

The Ohio State Board of Health is preparing to make a systematic investigation of the sources of the water supplies in Ohio, with the view of determining their fitness, as regards quantity and quality, for municipal and domestic uses. No hydrographic map of the state has been made, although the various state and county maps that have been published contain more or less complete information in regard to the streams. One of the first things to be done will be the preparation of a drainage map, which it is hoped can be made fairly accurate from the information at hand. The areas of the various water sheds, the inhabitants per square mile upon each, the cities obtaining water supplies from streams, and those contributing sewage to them, with certain other general features, will be shown upon this map. Monthly examination, chemical and bacteriological, of samples of water collected from the different streams at points where water supplies are taken or sewage discharged into them, will be a feature of the work. Inspections will also be made to determine as nearly as possible the amount and character of polluting material received by various streams.

A valuable part of the work will be stream gaugings. Heretofore but little has been done in this direction in Ohio, and the minimum flow of most of the streams is an unknown quantity. Of very great interest will be a report promised by Dr. Orton, State Geologist, on the underground water supplies of Ohio. Dr. Orton's knowledge of this subject undoubtedly (speaking of Ohio) is greater than that of any one that could be named, and his report will be invaluable to the smaller towns

which must in the near future seek for public supplies. It is hoped that Dr. Orton may also find time to prepare a map showing the location of the water-bearing strata of the state.

For the present the work will be confined to two or more rivers, probably the Olentangy, Scioto and Mahoning—rivers which already present many important problems to the cities depending upon them for water supplies or carriers of sewage.

The board hopes to be able to continue the work from year to year until a complete report can be made upon the water supplies of Ohio.

The foregoing article in every respect is to be commended, so far as it goes. But it does not go far enough, nor will the vast work outlined by Dr. Probst be likely to be accomplished within a reasonably short time. Our condition, as a state, is much like a person who is dangerously sick; procrastination means death. The doctor must get there quick.

Our present water supplies should receive early and prompt attention. We should certainly look first to the interest of the living, and then provide for future generations. If we can accomplish both, so much the better. If we err, it will be in the face of evidence that is indisputable, vast in extent, comprehending every known country where public water supplies have been introduced. May Ohio be one of the first states in the Union to speak the praises of a pure life-giving and life-sustaining water supply.

In the preparation of the foregoing paper the writer desires to acknowledge his indebtedness to Dr. Samuel W. Abbot for valuable reports of the State Board of Health of Massachusetts and to Mr. Allen Hazen for his work on the "Purification of Water," which the writer has drawn upon.

WATER WORKS AND FILTER PLANT OF THE CITY OF WARREN, O.

BY HOMER C. WHITE, WARREN, O.

Upon the 10th day of September, 1886, an ordinance was passed by the City Council of Warren, Ohio, granting certain rights to Samuel R. Bullock & Co., authorizing the execution of an agreement for the construction of water works in said city, the essential features of which were as follows:

The franchise was to cover a period of twenty years, during which time Samuel R. Bullock & Co., or their successors, etc., are required to furnish the city and its inhabitants with good, wholesome water for public, manufacturing and domestic purposes. The water to be taken from the Mahoning river above the Camp and Randall dam, and to be conducted through settling basins or reservoirs and filters to free it from all impurities; then to be forced by direct pressure from the pumping engines to a stand-pipe twenty-two feet in diameter and not less than one hundred and thirty-seven feet high and erected on a superstructure in such a manner as to give a practical working head or pressure, suitable and sufficient at all times to supply the city with an ample supply of water for fire protection, domestic and manufacturing purposes. Two pumping engines, each with a capacity of one and one-half million gallons, or a combined capacity of three million gallons in twenty-four hours were required. The power and capacity of machinery must be sufficient to throw from any six fire hydrants, simultaneous streams through one hundred feet of two and one-half-inch rubber hose and one-inch ring nozzle, to an average vertical height of one hundred feet for a period of one hour, or less, as the mayor and council may determine, and upon this test being successfully made, the city shall be obliged to pay the hydrant rental hereinafter provided. The city reserves the right to repeat this test as often as desired for a period of one year, and if at any time the works should fail to come up to the test, the rental of the hydrants should cease until they should stand the required test. The pipe system to consist of twelve miles of the very best cast iron pipe, varying in size from six to sixteen inches inside diameter, tested to 300 pounds per square inch, coated inside and out with Dr. Angus Smith's preservative varnish. All pipes to be laid not less than four and one-half feet below the established grade of the street. The engine, stand pipe and supply mains to be connected in such a manner that the water can be shut off from being pumped into the stand pipe, and be forced directly by the engines into the supply mains. The city rents for a term of twenty years, one hundred anti-freezing, double-nozzle, fire

hydrants at an annual rental of forty-five dollars each, and the privilege of renting additional hydrants at the rate of thirty-five dollars per annum for the first additional twenty-five hydrants and twenty-five dollars each for each additional hydrant thereafter. The hydrants are to be used exclusively for the extinguishment of fires, necessary practice and drill of fire companies, and flushing and washing the city sewers and gutters. Water is furnished free of charge to the city buildings, public schools, churches, and for one drinking fountain for man and beast in each of the First, Second and Third wards of the city, and for one ornamental fountain in the public park. Future extensions of the mains are to be made to any part of the city, when requested by resolution of council, provided three responsible consumers are secure for each three hundred feet of extension asked, who shall agree in writing to take, use and pay for water at established rates for a term not less than two years as soon as the mains are laid, or the city shall rent an additional hydrant for every five hundred and twenty-eight feet laid, no extension to be smaller than six inches inside diameter. The privilege and franchise herein granted are forfeitable on failure of the water company to supply the city with water for ten consecutive days. The city has the privilege, at the expiration of each period of five years, upon giving six months notice in writing, to purchase the works at a valuation to be ascertained by arbitration in case the city and the water company cannot agree upon the price. If any considerable number of water takers cannot agree with the water company upon annual rates, the rate shall be determined by the average rate paid in any other five cities in the state of Ohio, having about equal populations to the city of Warren and similarly constructed works, council to select the cities and determine the average rate. The works were to be completed within one year from date of contract, but owing to the enterprise of the contractor, only one-half that time was required. On the 10th day of May, 1887, the tests provided for in the contract were made, and declared in council, May 14, 1887, to be satisfactory and thereupon a resolution was passed accepting the works; the hydrant rental, however, not to begin until June 1, 1887.

The plant as constructed by Samuel R. Bullock & Co., consists of two horizontal, duplex, compound, condensing engines, stroke of piston rod, eighteen inches; diameter of water cylinder, twelve inches; diameter of steam cylinders (high pressure), fourteen inches; low pressure, twenty-six inches. The engines were made by the Dean Steam Pump Co., of Holyoke, Mass., 1887. The pumps are run under a boiler pressure of ninety-five pounds to the square inch, and guaged to make about 50,000 revolutions in twenty-four hours, under which conditions about 1,500,000 gallons will pass through each set of pumps in twenty-four hours. Ordinary pressure on water cylinder is 55 pounds per square inch; fire pressure is 110 pounds per square inch.

Originally the plant was supplied with two of Root's Improved Water Tube Safety Boilers, consisting each of sixty-four 4-inch water

tubes, sixteen feet long; later, two additional boilers were added to the plant. This addition was made on account of the extra work undertaken by the water company, to-wit: furnishing the city with electric light. The latter boilers, made by the Phoenix Iron Works, of Meadville, Pa., are sixteen feet long and are 66 and 72 inches in diameter respectively, the larger containing 72 four-inch flues and the smaller 56 four-inch flues. The boilers are so connected that they may be used as desired, all, singly, or in pairs. Ordinarily but one set of pumps is in use at one time, and the electric plant only at night. During the day two of the boilers will be in operation and at night three, the fires under one of the boilers being banked during the day. The water-tube boilers are considered by the engineer best for raising steam rapidly, but they require a steadier fire and more trouble is experienced from the accumulation of scale than with the other boilers.

The coal is shoveled by hand directly from the coal pits upon the fire grates under the boilers.

The water used in the boilers is taken from the Mahoning river, and this we expect to show is not a suitable water for boiler purposes. An effort has been made to use water from a deep well near the pump station, which has not proven to be a success owing to a tendency on the part of the boilers to foam.

Amount of pipe laid as follows: 340 feet of 16-inch, 340 feet of 14-inch, 4250 feet of 12-inch, 3050 feet of 10-inch, 9600 feet of 8-inch, 56,500 feet of 6-inch, and 14,000 feet of 4-inch, making a total of about seventeen miles of mains.

Number of hydrants, 119; number of private connections, about 1000, serving, say, 6000 people. Population of city, 10,000. Amount of water pumped daily, 1,500,000 gallons, making an average of 250 gallons per capita to actual consumers, or 150 gallons per capita to total population of city.

Meters in use consist of three 4-inch, two 2-inch, one 1½-inch, one 1-inch and ten ⅝-inch. The ⅝-inch meters are on residence lines, the others are on lines to mills and factories. Water motor power is furnished to two printing companies, one bakery and some three or four other small establishments.

The electric light plant consists of one Ft. Wayne, Wood, 60 light, 2000 c. p. machine; also, same make, one 40 light, 2000 c. p. machine; also, one 80 light, 2000 c. p. Brush machine; also, one 1500 light, 16 c. p. Westinghouse Alternating machine; one Standard Westinghouse engine, 100 HP., and one Compound Westinghouse engine, 150 HP.

Main arc wire, 30 miles.

Main incandescent wire, 8 miles.

Meters, 36.

Cost of plant, $28,000.

No. of incandescent lights, 16 c. p., about 2000.

Cost per light, 60 cents per month, or half a cent per meter hour.

No. of midnight arc lights, 2000 c. p., 68; cost per anuum, $55.

No. of all-night arc lights, 2000 c. p., 46; cost per annum, $80.

No. of commercial arc lights, 44; cost per annum, one light, $5; two lights, $9; three lights, $12.

The original cost of the water works plant is not readily to be obtained at the present time. The plant was constructed by a stock company, the greater part of the stock being held by parties residing in New York City. Bonds were issued to the amount of $150,000 and were sold to Post & Pomroy, of New York. Shortly after the sale of the bonds the contractors, Samuel R. Bullock & Co., failed. Later, The National Water Works and Investment Co. came into possession of the plant, which is at present managed through the First National bank of New York. R. B. Dodson and C. D. Backus, of New York, being the President and Secretary, respectively, of the new management.

George H. Quinby, of Warren, Ohio, was local superintendent from the completion of the works to the summer of 1897, at which time his resignation was tendered the company, whereupon Assistant Superintendent F. L. Geiger, also of Warren, was promoted to the vacancy, who served in that capacity until January 1st, 1898, at which time C. E. Inman, of New York, was appointed by the company to superintend the works.

Mr. Inman very kindly furnished the following statement of the annual cost of operation of the plant:

Year.	Water.	Light.
1889	$4,169	
1890	$4,169	
1890	3,865	$2,138
1891	5,198	5,727
1892	8,005	6,056
1893	7,973	6,146
1894	8,325	6,757
1895	8,179	7,061
1896	12,244	8,146

Expenses and receipts for the year are reported as follows:

REVENUE—1896.

Water—

City Rental		$ 5,500
Railroads		1,390
Private takers		9,668
		$16,558

Light—

City rental	$ 8,395	
Private users	4,449—	12,844
Gross		$29,402

OPERATING EXPENSES—1896.

Water	$12,244	
Light	8,146—	$20,390
Net		$ 9,012
Interest on bonds ($150,000 at 6 per cent.)		9,000
Surplus		$ 12

The increase of operating expenses in the water department, for the year 1896 ($12,244) over expenses for the year 1895 ($8,179), was due to the construction of a filter which was placed in the plant during the year 1895 at a cost of about $20,000.

THE FILTER PLANT.

The city of Warren is located on the banks of the Mahoning river, which runs in a southeasterly direction through the city, leaving about one-third of the city on the west bank, and two-thirds of the city on the east bank of the river, three-fourths of the population being on the east side. The first settlers upon the present site of the city of Warren arrived in the year 1799, and numbered, all told, twenty-nine souls. In 1870, the population was about 4500; in 1890, about 6000; and at the present time (1898) the population is about 10,000. The village of Warren was incorporated by act of legislature on the third day of March, 1834, and was re-incorporated in 1869 as a city of the second class and fourth grade. The first public sewer in the city was commenced in the year 1866, and up to 1874 about four and one-half miles of sewers had been constructed at a cost of about $100,000. The total sewerage of the city at the present time will approximate very nearly fifteen miles.

In the original construction of the water works, the filter was composed of gravel, charcoal, sponges, etc., encased in a network of wire matting, so arranged as to form a vertical wall separating the filtered water from the unfiltered water. Of course, this worked beautifully for several days—long enough, at least, to get the water plant accepted by council and the bonds sold. But soon there was trouble. Water would not go through the filter. Something must be done and done quickly. Soon that portion of the basin allotted to filtered water, the capacity of which was entirely too small, would be exhausted, and water must be obtained some way to keep the pumps going. The only practical way which presented itself was to take a crow-bar and knock several big holes through the filter and let the water in, which was accordingly done, after which, of course, there was no lack of water; but upon the question as to whether or not the water furnished by the company was good and wholesome and free from all impurities, many people could be found who did not hesitate to express themselves in language more forcible than polite, in favor of the negative. Com-
ints were heard on every hand. It was not the bacteria in the wa-

ter that the people objected to, for many of them had been raised from infancy on water from wells contaminated by cess-pools and privy vaults, and were proof to attacks from bacteria. A few million bacteria, more or less, in a drink of water, cut not the slightest figure; but they did object to having mud, eels and dead fish served up with their coffee or swimming in their lemonade. I think this was the principal reason why so many of the population about this time quit drinking water altogether. General dissatisfaction with the quality of the water began to be apparent. As early as 1888, two years after the completion of the works, a note of warning was sounded by the Board of Health through its health officer, Dr. S. H. Smith, who, in his report to that board, dated April 16th, 1888, after recommending the adoption of the Hyatt System of Purification and extending the inlet further up stream, says:

"By this means the water of the Mahoning river can be made at all times as soft and as clear and sparkling as spring water. It will not only be pleasant to the sight and taste, but will be far more safe to use for drinking and domestic purposes than any well or cistern in the city, and it will be but a short time before a majority of the citizens will recognize these facts and will abandon all other sources of water supply. But as the water now is, taken from a mill dam, without even the chunks of organic matter strained out of it, loaded with clay, with several sewers emptying into the river above the dam, and other sources of pollution, which it seems now almost impossible to remove, it is unsafe water to drink and is totally unfit to use for culinary purposes, even after it has been boiled, and no one should be allowed to use it."

And thus matters continued until September, 1892, when the city council refused to pay the hydrant rental then due, and in May, 1893, suit was commenced in Common Pleas court by the City of Warren, praying that the water company be required to comply with the requirements and conditions of its contract, to furnish the city and its inhabitants with "good, wholesome water, free from impurities." About the same time the water company commenced action against the City of Warren to recover back hydrant rental, and thus for several years the war waged, now in the Common Pleas and now in the Circuit Court; sometimes the city was in the lead, at another time the decision was in favor of the water company, but, not desiring to weary you with details and legal phrases, the outcome of the whole matter ended in the city council accepting the invitation of the water company to inspect a filter adopted by the water works of Knoxville, Tennessee, known as the Warren filter. The report of the committee was unanimously in favor of the adoption of the new filter, whereupon arrangements were at once made with the water company to have the new filter placed in the plant.

The Warren filter is manufactured by the Cumberland Manufacturing company of Boston, Mass. Walter B. Nye is manager of the

company, to whom we are indebted for the following description of the plant:

"A Warren Filter plant usually consists of a settling basin, and one or more filters, and a weir for controlling the head, together with the necessary pipe connections. Each filter contains a bed of fine, sharp sand, two feet in depth, supported by a perforated copper bottom, and for cleaning this bed an agitator is provided. This consists of a heavy rake containing thirteen teeth twenty-five inches long, rotated by a system of gearing and capable of being driven into the bed by means of suitable screw mechanism, whereby the entire bed is thoroughly scoured.

"The process of filtration is as follows: The water enters the settling basin through a valve operated by a float, by which a constant level is maintained in the entire system. The water entering through this valve passes through an eight-bladed propeller of brass, from ten to sixteen inches in diameter, so arranged as to revolve freely with the passage of the water. This, by means of two small bevel gears and an upright shaft operates an alum pump, of unique design, on which we hold letters patent, consisting of six hollow arms radiating from a chambered hub and bent in the direction of rotation. This pump revolves in a small tank containing a dilute standard solution of sulphate of alumina or other coagulant, and by its revolution each arm takes up its modicum of alum water, passes it into the hub and to the deflector, which sends it down to the incoming water.

"The incoming water having received its proportionate amount of coagulant, is then allowed to remain in the settling basin from thirty to forty minutes, to enable the chemical reaction between the coagulant and the bases in the water to take place and to permit of the heavier sediment, together with a portion of the coagulated matter, to settle by subsidence to the bottom of the tank, where it can be drawn off at intervals into the sewer.

"The water, with all the fine silt, suspended matter, as well as practically all the bacteria and other germs present in the water, bound and held together by the insoluble hydrate of alumina resulting from the addition of the coagulant, passes on through suitable piping and valves to the filter, and, filling the tank, passes down through the fine sand bed, leaving all the coagulated matter upon it and making its exit from the filter through the main, bright, clear and sparkling, and perfectly adapted in every way for domestic purposes.

"The main, collecting the filtered water from the various filters, passes along between them to the head-box, or weir, over which the water is compelled to pass, and which controls the operation of the filters. The top of this weir is twenty inches below the water level maintained in the filter system, and this head of twenty inches (equivalent to a pressure of three-fourths of a pound to the square inch) is the extreme pressure that can be brought to bear upon the filters, and it is evident that they cannot at any time be pushed beyond the rate which experience has shown to yield the best results.

"When the bed of a filter becomes clogged, and it seems best to clean it, the inlet and outlet valves are closed, and the wash-out opened allowing the contents of the tank to escape to the sewer. The agitator is then set in motion by means of the friction clutch with which it is equipped, and as the teeth on the huge rake begin to plough up the surface of the bed, a slight amount of filtered water is allowed to flow back up through the bed, in order to rinse off the dirt loosened by the scouring action of the rake. This is kept up until the rake penetrates to the bottom of the bed and thoroughly agitates every particle of material therein. As soon as the water flowing to the sewer appears to be clear, the motion of the rake is reversed and it is slowly withdrawn from the bed. When the teeth are raised above the bed the waste pipe is closed, the inlet valve opened, and the filter tanks allowed to fill. After waiting a few minutes for the tank to resume its normal condition, the outlet valve is slowly opened and filtration is resumed.

"The coagulating apparatus consists of a series of tanks for dissolving the sulphate of alumina and preparing the solution, and a tank for its delivery to the incoming water. The sulphate of alumina is placed in the upper tank, and there, by means of water and steam, admitted through a lead tee, a concentrated solution of it is made. A small portion of this is drawn off into the lower and larger tank, and mixed with water until a solution containing from 5 to 3 per cent. of alum is formed. This weak solution is then fed into the small rectangular box, in which revolves the alum pump already described.

"The filters are designed to operate under a head of twenty inches or less, and have a bed of fine, sharp quartz sand from twenty to thirty inches in depth. No. 1 is 8 feet 8 inches in diameter; net area 56 square feet, capacity 200,000 to 250,000 gallons per 24 hours. No. 2 is 10 feet 6 inches in diameter; net area 84 square feet, capacity 300,000 to 375,000 gallons per 24 hours. No. 3 is 12 feet 6 inches in diameter; net area 122 square feet, capacity 400,000 to 600,000 gallons per 24 hours.

"The amount of power required for operating the agitators is small, not over four or five horse-power, and as but one filter is washed at a time, the size of the plant does not affect the amount of power required.

"The frequency of washing depends, of course, upon the character and amount of matter to be removed. Where much organic matter is present, safety demands that the accumulation in the bed be soon removed, and the filters should be washed at least once in twelve hours."

At Warren, the water is taken directly from the river into a settling basin, 54 feet long, 22 feet wide and 10 feet deep. It is here treated to the alum solution, ordinarily in the proportion of about one barrel of alum to three million gallons of water treated. In actual practice, the quantity of alum used varies according to the condition of the water. During freshets when the water is quite muddy, the amount of alum used may be doubled, and when the water is comparatively clear, the use of alum is frequently dispensed with entirely. A barrel of alum weighs 330 pounds and costs $5.65 per barrel.

The following analysis of Mahoning river water, kindly furnished by the Cumberland Manufacturing company, shows what is claimed for the filter:

"Bacterial analysis of Mahoning river water, from Warren, Ohio, before and after treatment by the Warren Mechanical Filter.

Hours of Collection of Samples	No. of Bacteria in 1 c. c. of Water		Percentage of Removal as Compared with Average of River Water Samples
	River Water	Filt'r'd Water	
10:15 A. M.	2373		
1:15 P. M.	938		
4:30 P. M.	1248		
Average No.	1520		
10:00 A. M.		16	98.94
11:00 A. M.		11	99.27
12:00 M.		11	99.27
1:00 P. M.		41	97.30
2:00 P. M.		97	93.61
Filter	Washed		
3:00 P. M.		28	98 16
4:00 P. M.		11	99.27
5:00 P. M.		10	99.34
5:55 P. M.		9	99.40

"As the river water remains in the settling basins and filters fully two hours before passing the filter beds, the results of the analysis of filtered water are compared with the average of the three samples of river water."

I desire, very briefly, to call your attention to several analyses of river and well water made for our city at the request of our Board of Health, and for the reason that to those of us who have not mastered the mysteries of the chemical analysis of water, a bare statement of results would be of little value, I append the chemist's explanations accompanying each case.

	Total Solids	Chlorine	Free Ammonia	Albuminoid Amm.	Oxygen Consumed	Nitrates	Nitrites
No. 1 (River Water)	240.0	4.2	.070	.502	8.6	Trace	.020
No. 2(Deep Well Park Av.)	1519.2	235.0	.748	.242	4.0	None	None
No. 3(DeepWell Main St.)	1400.4	352.0	.840	.080	3.6	None	None
Deep Well at Charleston	1170.0	130.0	.300	.040	2.1	None	.368
Cochituate Water of Boston	60.0	3.6	.070	.255	7.4	0.18	Trace
Croton Water of New York	90.0	0.7	.020	.150	3.4	Trace	Trace
Schuylkill Water of Phila.	130.0	6.0	.105	.210	2.1	0.22	Trace

Results given as parts per million.

No. 1—Opalescent with grey sediment—odorless—residue blackened on ignition, emitting very slight nitrogenous odor.

No. 2—Nearly clear with slight grey sediment and floculent black particles—odorless—residue blackened slightly on ignition, emitting a strong nitrogenous odor.

No. 3—Characteristics, same as in No. 2.

The above anaylsis was accompanied by the following explanatory letter:

Case School of Applied Science,
Cleveland, Ohio, Sept. 13, 1887.

Mr. George P. Hunter:

Dear Sir—In answer to your note of Sept. 10th I desire to give you a bit of information concerning chemical work in general, and water examinations in particular. * * * * * * There are no secrets in chemical work and no value can be attached to results that are not based upon all the general knowledge that can be obtained, as well as upon methods that are above criticism. In regard to water analysis, if the party having the work done can interpret the results of analysis, it is only necessary to hand in the results, but if the chemist is asked to give his opinion, he must have all the information he can get as to the source of the water, and all possible contamination. To illustrate: We suspected that samples 2 and 3 came from deep wells and had been in contact with natural salt beds. If these samples had been taken from your river, it would have shown a very bad condition of the water. As it is, while these samples are not first-class drinking waters, they are fairly good. The objectionable feature is the high percentage of free Ammonia (N. H. 3), which indicates contamination by water that had contained organic matter that had undergone oxidation, leaving as one of the products, free ammonia. Perhaps surface drainage, to a small extent, ultimately finds its way into the wells. Neither the salt nor the lime (total solids) do harm, although they are present in large quantities.

Sample No. 1 is contaminated with organic matter, probably of vegetable origin, as shown by the high proportion of albuminoid ammonia, small amount of chlorine, and the character of the organic matter, which is that of a vegetable nature. This sample would be regarded as objectionable, although at present not absolutely dangerous.

High solids in Nos. 2 and 3, also high chlorine, results from contact of the water with lime and salt formations. They are not hurtful to drink, but probably the water is too hard for domestic purposes.

Solids and chlorine in No. 1 may be regarded as normal to good water. The worst feature of No. 1 is the high albuminoid ammonia, and oxygen consumed, which has a similar meaning. Perhaps it is improved by filtration.

To the results on samples received from you, we append analysis of the water supply of Boston, New York and Philadelphia; also analysis of a well in Charleston, S. C., that was thought to have caused disease.

* * * * *

Evidently your river water does not suffer from contact with sewage. Yours truly, C. F. MABERY.

The following analysis and letter refers to samples taken from deep wells, one of which was from the public well in the City park.

PARTS OF IMPURITIES IN 1,000,000.

	Samples.	
	No. 1.	No. 2.
1, Total Ammonia (N. H. 3)	.410	.220
2, Free Ammonia (N. H. 3)	.046	.020
Albuminoid Ammonia (by diff.)	.364	.200
3, Nitrogen in the form of Nitrites	.010	.005
4, Nitrogen in the form of Nitrates	6.000	4.900
5, Total Solids	734.800	890.400
Loss on Ignition	62.900	94.300
6, Chlorine	74.200	57.000
7, Oxygen required to Oxydize Organic Matter—		
Method of Tidy (3 hours)	1.000	1.400
Method of Tidy (24 hours)	1.600	2.000
Method of Kubel (Boiling 10 minutes)	2.000	2.800
Method of Wanklyn (By Evaporation)	6.800	6.600

When evaporated to dryness, the residues of both samples blacken, and oxides of nitrogen are freely evolved upon ignition.

Case School of Applied Science,
"Cleveland, Ohio, Dec. 26, 1888.

"Mr. Geo. P. Hunter:

"Dear Sir—Analysis of the samples of water received from you gave the following results:

"Samples 1 and 3 both clear, nearly colorless, odorless, with a slight sediment of lime and vegetable matter. Sample 3 has a slight, yellow tint. I will give the analytical results on another sheet and I will endeavor to give a plain interpretation of the results in order that you may understand the basis of the opinion which I shall express concerning the quality of the water.

"In an analysis of a suspected water, especial importance is attached to albuminoid ammonia, nitrogen in the form of nitrites, and in the form of nitrates, to chlorine, to oxygen required to oxydize the organic matter, and to loss on ignition, especially if the residue blackens when heated.

"I will now explain the results in order:

"Free ammonia is not excessive. Albuminoid ammonia, when present in quantities exceeding 0.200 part in one million parts water, indicates a questionable condition of the water. Ammonia in this form is evolved from substances that must not be present in drinking water. You will perceive that No. 3 is at the limit, and that No. 1 is far beyond.

Nitrogen in the form of nitrites or nitrates must not be present. You will observe that it is present in both forms and in very large quantities as nitrates. This fact, confirmed as it is by the behavior of the water residue upon ignition is sufficient to condemn both samples.

"Solids in solution are very high, although I have seen very hard waters that were not unhealthy with nearly as much solid matter in solution. Loss on ignition is also very excessive and together with the blackening and evolution of oxides of nitrogen, it shows a bad condition of the water.

Chlorine is very excessive, and if there are no salt springs in the vicinity, showing a salt formation in the neighborhood, it must show contamination of the water by drains, cess pools or sewage in some form.

"I give results of the three methods we use to ascertain the consumption of oxygen, since each method gives valuable indications with different kinds of contamination. In this case, the best information is given by the Wanklyn method, which shows by the large quantity of oxygen consumed (6.8 and 6.6) that the water contains more substances requiring oxydation than should be present in potable water."

"Referring now to my statement above beginning with the words 'In an analysis," etc., in my opinion each of the two samples of water is unfit for drinking purposes and neither should be used as a potable water. * * * * *

"I could not give the opinion you desire as to the character of the water without all the data from the seven determinations. It is one of the comparatively few cases where nitrates have been found in considerable quantity in drinking water which may have caused typhoid fever and it is, therefore, an interesting fact. I remember the deep well from which Mr. Smith analyzed the water last year contained considerable salt, and it may be that a part, at least, of the chlorine in these samples, is present as natural salt.

"Yours very truly,

"C. F. MABERY."

The following letter and analysis refers to the deep well on the Water Works company's lot.

"Case School of Applied Science,

"Cleveland, Ohio, Oct. 9, 1894.

"Hon. Wm. T. Fee, Warren, Ohio:

Dear Sir—The analysis of the well water shows its quality to be exceptionally poor and that it has been badly contaminated. It should certainly not be used for drinking purposes unless previously boiled. I enclose report of results as follows:

Free Ammonia	2.366
Albuminoid Ammonia	2.860
Chlorine	705.470
Total Solids	1206.000

Loss on Ignition	41.000
Nitrates	0.060
Nitrites	Trace.

Results as parts per million.

"Free and Albuminoid Ammonia, Chlorine and solids are about as high as in sewage. ALBERT W. SMITH."

The conclusions of Professor Mabery and Mr. Smith are corroborated by the reports of the deaths occurring in the city of Warren from 1888 to 1898. During the ten years between the above dates, the total number of deaths from all causes were 700, of which 18 were by typhoid fever, and in every case, where typhoid fever was contracted within the city, the deceased had been drinking well water.

Note.—For a full discussion of the river water at Warren for the summer of 1897 and for analysis and results of bacteriological examination of river water and of the filtered water see "Preliminary Report of an Investigation of Rivers and Deep Ground Waters of Ohio as Sources of Public Water Supplies," by the Ohio State Board of Health, 1897-1898. The tables, diagrams and discussions are too voluminous to be included in this report, otherwise they would be quoted here.

OWNERSHIP AND THE ECONOMY OF COMBINED WATER WORKS AND ELECTRIC LIGHT PLANTS.

B. J. ASHLEY, CHICAGO, ILL.

The economy of combining water works and electric plants is fast becoming to be recognized favorably by lesser municipalities throughout the country, and many villages are hastening to adopt the idea as they are clothed with the authority and given the means by which to carry the idea into effect.

These villages and hamlets are rapidly coming into the field and demanding these desirable improvements, long ago adopted by the cities and towns of more considerable importance, to such an extent and with such spirit, that at times the rivalry of neighboring towns becomes exceedingly warm and interesting as to which shall secure the coveted improvements first as well as to which shall obtain the best.

It is a commendable fact that villages universally desire the best plants obtainable, but disappointments are bound to follow when members of councils conclude to follow along ideas of their own, for the sake perhaps of appearing to their constituency to be persons of ability and importance, or to enjoy the selfish gratification that attends the acts of persons of such narrowness, rather than to act broadly in the light of doing the greatest good to the greatest number irrespective of personal advancement and profit, by following along lines consistent with the best class of business methods.

Questionable integrity among officials in charge of the establishment of such plants is almost surely to give the same undesirable results.

Want of a sufficient appropriation to establish perfectly and properly equipped plants is also a serious menace to the engineer who fortunately or unfortunately may have been employed to design a plant according to the instructions of the Council or Board of Trustees.

Failure on the part of a council to follow the direction and advice of a competent and honest engineer, is very likely to result in the useless expenditure of money.

It is, therefore, desirable, although not often obtainable, to have men in the council thoroughly sensible, not hasty, and with business ability, backed up with sterling integrity.

The want of funds has often prompted towns to grant franchises to private individuals to erect and operate plants in their corporate limits for the revenue the company or individual can obtain by it.

This course is usually attended by the making of a previous contract between the municipality and contractors, wherein the latter is to furnish light or water or both at a certain rate per unit, specifically written, but without reference to the quality, or sufficiency of the ma-

chinery to hold up and continue to produce the quantities bargained for, which quantities are in rare instances ever measured. These contracts are usually drawn for a period of years from say five to twenty.

That such a time contract should be given to the contractors, is entirely just, and the reason is obvious without further discussion, except to say, that capital would be quite unwilling to invest itself in establishments of permanency without a certainty of income for an adequate time, which time is fully stipulated in the agreement.

Such methods as that of quantity these franchises are chiefly employed in western towns and villages that have never made any attempt heretofore at establishing modern municipal improvements, while the scarcity of adopting these methods is equally as true of the eastern states.

Without discussing the "pros" and "cons" as to why the above can be said of these existing conditions, it is deducible and experience has long ago proven that the results obtained by the granting of franchises to companies or individuals to build, equip and operate either of the character of the plants under discussion, have never, as a rule, been attended with harmony among all parties to the contract, nor in many cases with satisfactory results, nor very low rates for service.

Among the causes for the perplexing embarrassments that have constantly arisen and will continue to arise is the fact that it is universally the practice for the contractors, who, for the sake of argument, we will admit, understand their business, to originally draw and frame the agreement sought to be entered into, which agreements are often found to contain clauses, the meaning of which, to the average councilman, who admitting rarely understands the business, seems to be clear, but in the end or rather before the end, are found to contain hidden meaning, or which are sufficiently ambiguous as not to be easily understood by others than persons experienced along these lines and, therefore, more competent to judge.

Viewing this question from the standpoint of the served, looking toward the party being served, the frailty of human nature to get as much as possible and give as little as possible in return often shows itself in a form that is not very pleasant to contemplate and presents features not easy to manage.

Lack of what a Yankee would familiarly call "backbone" in the personnel of the council to enforce the provisions of the agreement that are disregarded, would be also termed among the numerous unnamed reasons why disappointing and undesirable results follow the wake of a franchise.

The municipal ownership of water works and the individual ownership of the electric light plant is a poor example of economy for a village to adopt inasmuch as the return upon the investment in a water works plant is not so immediate as from that of an electric light plant and the town is giving the other fellow the sweetest of the meat, while the municipality is usually running short in its accounts through its

early period of operation because of insufficient income to pay the expense of operation, and the interest on the investment, and the contrary is ordinarily true in the installation and operation of the electric light plant.

It is quite impossible to name the numerous difficulties that are constantly arising and the expensive service that is usually attending this manner of securing either or both of this class of service and we are warranted in believing the question of ownership must be decided with the preference extended toward the municipality.

Concerning the economy of combining the two systems, the subject resolves itself into two parts, viz.:

1. Cost of installation and
2. Cost of operation.

To make this question plain to the ordinary business man is an easy task, but should a council be composed of indifferent men, some of whom perhaps are incompetent to maintain successfully a business of their own, satisfactory results should not be expected in their administration of affairs when passing upon questions about which they have but little and perhaps no understanding at all, unless they are willing to accept the opinions of those most competent to give safe counsel.

In the installation of plants by the granting of franchises, there is almost always contained in the agreement a clause whereby the village is privileged to buy the plant at or before the expiration of a term of years at a certain stipulated sum or at a price to be determined upon possibly by arbitration.

In determining upon this future acquirement of the plant in question, the council has no way of obtaining the true value of such a plant by the prices that would be revealed through methods of an open letting.

Its acquirements being remote at best elicits less interest from the councilman because of its remoteness, and the probability of his not being identified with the council at such a remote period results in carelessness in the original determination upon the price the village may be required to pay or the method by which such price is afterward to be settled.

Time runs on, the machinery becomes worn, changes take place in the personnel of the council, with the attending inexperience and want of knowledge an older member of the body would likely have; the superior knowledge of the proprietor of the plant over that of the prospective purchaser all assist in making the former an easy prey to the latter in closing a sale.

Without further discusison it is safe to decide that the method of installing plants for the use of municipalities through this ofttime convenient method of franchise and subsequent acquirement is not entirely business-like nor economical.

In operating under the laws of your state in the establishment of these plants, like the spirit of the law everywhere, the best for the least

money is sought to be arrived at, and open competition is recognized as the best plan of securing such results. This principle is one of the underlying ones in business and hence its safeness of adoption.

That the two plants can be originally installed under one roof, operated with the same power, under the same management and by the same operators is plain to be seen without enlarging upon the subject.

In this manner the cost of land is eliminated as well as the cost of the boiler plant, and the expense of a separate crew of operatives under a separate management is dispensed with, followed by a consequent reduction in expense, both of establishment and operation.

Taking for instance a village of three thousand inhabitants, requiring a water works plant costing say $30,000, and an electric light plant costing $15,000.

It is fair to say that the following would be the saving of cost of installation:

Land from	$200	to	$500
Well from	100	to	200
Boiler plant from	2000	to	3000
Building from	1000	to	2000
Total saving	$3300	to	$5700

It must be admitted that an experienced engineer having had years of dealings with municipalites can see farther into the future of villages and their prospective requirements than the inhabitants thereof themselves, and therefore his advice along the methods of installing work with reference to the future needs of a village is of much more value sometimes than that of its best business men who might be well versed in the management of its municipal affairs.

Such a case has recently been forcibly demonstrated to the writer in the instance of a town in which both electric lights and water works are now in operation.

Briefly stated the story runs about as follows:

Being called into consultation with village authorities concerning the construction of water works, advice was offered that under the existing conditions regarding the electric light plant already in operation in the town, under private ownership and management, it would be but a few years at least when there would arise a demand for the municipal ownership of that kind of a plant as well; and that the village had better adopt a plan of installation to which in the future might be added in combination an electric light plant.

Part of the Board was favorable toward adopting the advice offered, part were not, and part were neutral, but resulted in their deciding in favor of the engineer's views.

By the time the letting of contracts was to take place, in consequence of having had extreme influence brought to bear upon them by representatives of certain classes of machinery as well as by citizens who had been interested in its behalf for the individual benefits.

that may have been received for their influence, the members of the Board again found themselves divided and another class of machinery than that specified was permitted to compete. By the adoption of this class of service the possibility of ever combining with it an electric light plant was forever lost. Blinded to this future possibility, with its attending economy, the unspecified machinery was adopted and installed at an excess in cost of $1100 over that at which the plant with the specified machinery would have cost.

To the surprise of even the writer, in less than six months after the water works had been completed did the authorities undertake to bond the town for $13,000 for the purpose of buying the old electric light plant, which probably was not worth one-fourth that much.

Had not the citizens voted it down, the accounts would have stood about thus in comparison with the figures of the combined plant:

Present municipal water works	$25,000	
Present private E. L. plant	13,000	
		$38,000
Water works as specified	$24,000	
E. L. plant as advised	8,000	
		$32,000
Useless expenditure		$ 6,000

As it is, since the question failed to carry and a new plant can never be installed under a cost of about ten thousand dollars, saying nothing of the subsequent increased cost of operation, and here you have an instance of blind folly.

As we have said but little about the economy of operation thus far, another illustration of a town that followed the advice given it to the letter will go to show the possibilities of the cheapness of operation of a combined plant.

The town in question has a population of	900
Cost of combined plant, including land, water, engineering, printing, etc	$18,885
No. fire hydrants	20
No. 2000 cp. arc lights	21

At the end of eight months after the plant had been put into operation the following statement was given out by the mayor:

Water takers	36
16 cp. lamps	236
Average cost per lamp	29c

RECEIPTS.

Ins. lamps	$ 68 57
Lighting R. R.	20 00
Water rentals	20 00
	$108 57

EXPENDITURES (Monthly).

Coal, oil, supplies, etc.	$ 40 00
Engineer's salary	45 00
Trimming lamps	5 00
Clerk hire	10 00
	$100 00

You will note that the town is getting its light and fire protection without cost, while previously to the installation of this plant it was paying $800 for lighting alone.

It is due the plant to credit it with about $1200 for lighting and about $1000 for fire protection for a year, which the above account does not include nor show.

Since this article has come down to the statement of facts, it might be added that no charge is made against the water works department of this particular plant for operating it, as the amount is insignificant. The pumping is done late in the afternoon as the fires are being kindled for the night's run.

Contrast, if you please, the cost and operation of such a plant with that of any other character of installation and you have an example that is easy of solution to any one, whether he be a keen business man or a laborer of ordinary capacity.

You have the embodiment of good sense in the building of the one and the very allegory of stupendous error in the establishment of the others.

DISCUSSION.

Mr. White: I would like to ask Mr. Ashley if it is not a fact that works of this nature, when operated by a municipality, cost more for operating expenses than when operated by a private concern?

Mr. Ashley: I will have to answer that by referring to past experiences, and from past experience in public enterprises I will have to answer in the affirmative. I have regarded this, however, from the standpoint of a business, not a political management.

THE LEGISLATURE AND THE ROADS.

J. A. HANLON, COSHOCTON.

The enactment of laws looking to the improvement of our public highways lies, of course, with the Legislature, and while this is so, we as individuals or associations may make our recommendations and point out the defects in existing statutes, which now direct and regulate the construction and maintenance of highways. By virtue of such experience and training as we may have had, we may hope that our recommendations may have consideration in the preparation of new legislation on highways.

It must be admitted that the general laws now governing the building and keeping in repair of public roads is not abreast of the times, excepting in such counties as have availed themselves of special legislation or have proceeded under the pike laws and paid for the roads by assessment under the one or two mile plans.

The particular feature of the road system which seems to require especial revision is that of maintenance, which will apply alike to improved and unimproved roads. In no part of the whole expenditure of road funds for all purposes is there such waste of money without adequate results as now practiced under present laws. The first step, that of the township levies to provide funds for caring for the roads, lacks uniformity. The township trustees are allowed to levy from nothing to two mills for road purposes, regardless of the number of miles of road in the township to be cared for, or of the natural conditions which may affect the cost of keeping the roads in repair.

Under the present law this road tax, as paid in labor, can only be applied from about the first of June to the 5th of September, at which time the Road Supervisor is required to report to the township clerk the amounts paid or unpaid, in labor or cash, in order that these credits may reach the tax duplicate prior to the December collection of taxes. So that the bulk of the funds available for road repairs is expended upon the roads within a space of three months, regardless of the wants prior to June 1 or after September 1.

It is true that the two days' labor and any taxes not paid in labor, such as railroad taxes, and these, if non-residents, may be returned to the townships later and worked out in other months than those mentioned; but in comparatively few townships does any considerable fund arise from these sources. So that it may be fairly considered the repair or maintenance work for at least nine months of the year is crowded into the three summer months.

Of the value of this road tax labor work or how much is realized from a dollar, many of us have from observations at least made our own estimates.

A few days ago I read a farmer's ideas of road working expressed in verse. The substance of it was that he took no recreation from his constant day in and day out labor, except when ordered out to work his tax on the roads.

To bring about uniformity as between townships, it is plain that the management of the maintenance of roads should be in the hands of a county official, and that instead of the work of repairs being confined to a few months, the system should provide for constant care and supervision, just as our railroads, both steam and electric, canals, streets, and in fact every method of transportation which involves wear and tear, and this system is followed simply because it costs less money to accomplish a given amount of work than by periodical overhaulings. The cost is the governing consideration and yet the laws of Ohio providing for the care of public highways have yet to provide for an economical expenditure of funds in this way.

The revision of the road laws of Ohio is an undertaking which should be begun at once. It is a matter in which all interested, which would certainly include everyone, should inform themselves, particularly the members of the Legislature.

The subject is entitled to such special consideration as has been granted to other matters; as by the appointment of a legislative commission in the case of the Ohio canals two years ago.

Ohio has not been to the front in the agitation of improved road laws, as has been done in some other states, as Michigan, Missouri, Delaware, New Jersey, Maryland and others.

In the states mentioned there are organized "Road Improvement Associations," or as some of them are known, "Good Roads Associations." No organization has used so much printers ink to good purpose in this direction as the organs of the League of American Wheelmen.

If the members of this society will request their respective members of the Legislature to give a friendly ear to any matters coming before them looking to an improved system of improved roads, they could not do less. As a Society and as citizens, we should aid them to the extent of our ability.

One of the wise provisions toward maintaining improved or even unimproved roads, by a former Legislature, was that of the wide tire law; but information is at hand that petitions will be presented to some of our legislators praying for the repeal of that law, on what grounds we have no information.

To comply with such a request as repealing this law would be a long step backward in any forward progress in a better system of building and maintaining public roads.

Such a bill should be entitled, An act to promote the malicious destruction of public property.

ROADS AND TRANSPORTATION.

ADDRESS BY HON. MARTIN DODGE.

In discussing this subject, I desire to take an economic view of it, as much as an engineering view, or more. What I shall have to say to you will be based upon changes which are now taking place, or which have taken place already, or which are about to take place, more than upon the engineering methods to be employed in actual construction.

The question is very broad in its economic bearings and as I have spoken to you on some portions of it before, I will venture to recapitulate the position I have taken upon the question of good roads and transportation.

I had the honor to be appointed by Governor McKinley in 1892 as chairman of the Ohio Road Commission, and at that time I formulated a report which was published in 1893. In this report I recounted some of the facts and some of the economic laws, and made some comparisons in reference to the cost of construction and cost of transportation. At that time, however, the problem was not so nearly solved as it is at the present time. The report of that commission, among other things, recommended that the state should not expend any large sums of money for road construction with reference to making through thoroughfares from one end of the state to the other, because if animal power should be depended upon as a means of transportation, it would be limited to too short a distance; but, that we were entering upon an era where another power would take the place of animal power to a great extent on the highways, and it would be better for the state to wait and watch, and compare especially those facts and figures which we published at that time and see whether there would not be evolved out of the then future a way which would be more beneficial and more satisfactory and more economical in application and operation than anything which it would be possible to recommend to enact into law at that time.

I will recapitulate somewhat as to the attitude of the state from a legal point of view, that is with reference to the acts of the legislature.

In the first place, I think that all understand that the means of transportation are the important, if not the most important of any factor in civilization. There is nothing which affects civilization so much, which affects the distribution of population so much, which affects the industry and the profits of industry, and even the rewards of labor so much as the means of transportation. That having been the prevailing view in the early history of the country, the general government built the National Road, which, as you know, was built through this state from Cumberland, Md., on west to the borders of the state. There was always contention as to whether it was wise, and also as to whether it was constitutional to appropriate money from the United States treas-

ury for such use. That contention was finally settled, not by the termination of the dispute itself, but by the introduction of a cheaper means of transportation than had been known in the United States before that time. When the steam railroad was demonstrated to be successful, and the Allegheny mountains were passed, the National Road was practically abandoned. From that time on, the economical gain that came in transportation, through the introduction of railroads, was so much greater than anything which could be done through the building of wagon roads by the state or nation, that interest was to a great extent lost in these enterprises and became wholly local.

From the time of the success of the steam railroad until the present time, the nation and the states have both failed almost wholly—the nation totally—to do anything more in the interest of highways. It was turned over to the counties and townships and road districts, and the cities took care of the streets within their limits. That condition has continued almost to the present time.

Now, within the last few years, there has been a wonderful revival in reference to rebuilding the wagon roads of the state and of the nation. The old doctrine that the nation should not take money from the public funds to do this work, I think is generally held. The United States appropriates a small sum each year for investigation as to the cost and methods of making roads, and the different means of transportation. The state is now facing the proposition as to whether it shall take the ground that the United States has taken and keeps hands off, or whether to make the issue a state affair in whole or in part, and provide by tax and appropriation for carrying it out.

The answer to that question must be determined by inquiring into the economical law and determine what the gain shall be by adopting one means or the other. At the time we made that report to the state, it was the general opinion that the wagon road system, with a view to the perpetual use of animal power, should be reinstated, and that the state should go forward with some aid at least in the continuation of those roads. Under those conditions it would not be wise for the state to tax one portion to build roads in another. But if any means of transportation should be discovered which would be so cheap and rapid that it would be used for long distance transportation, going from county to county and entirely through the state, the proposition would then be changed. I had faith then that inventions would be introduced which would demonstrate that we could build up a system of roads which would be sufficiently extensively used to warrant the expenditure of the money.

If horse power is to be depended upon, there is little hope that long distances will ever be reached by that power, or that long roads built by the state would ever be used, except locally, because horse power is expensive. The cost of horse power is twenty-five cents per ton per mile. I fixed somewhat arbitrarily the limit of profitable use as five miles, and the cost as one dollar and twenty-five cents per ton for that

distance. The electric cars are able to carry one ton twenty-five miles or farther at the same cost it could be carried five miles by horse power; and this estimate made by myself has been shown by actual service to be correct. The Commissioner of Railroads states that the cost of transportation by steam railroad is half a cent per ton per mile, which would give 250 miles for $1.25; and the steamships on the deep water of the lakes are carrying a thousand miles for $1.25 per ton. This comparison shows that all means of transportation except horse power has been greatly increased in power and decreased in cost for transportation, and the longer the distance the less the cost per ton mile. Upon this investigation, it was the judgment of the commission, that if horse power should be depended upon, it would necessarily be confined to the localities in which the transportation originated, and could not be extended to any great distances. During all the period of progress of our country, during the period of advance in civilization, there has been little or no increase in the power of the horse or other animals as a means of transportation. It is then the great problem before the engineers, and before the world, to take advantage more and more of these things which have been invented, tested and which nature has put within our power to aid transportation.

The Department of Agriculture has gathered reports from twelve hundred counties, giving the average length of haul in miles from farms to market or shipping points; the average weight of load hauled and the average cost per ton per mile. The average cost per ton per mile in the Eastern states is thirty-two cents; in the Northern states, twenty-seven cents; in the Middle Southern states, thirty-one cents; in the Cotton States, twenty-five cents; in the Prairie states, twenty-two cents; in the Pacific coast and Mountain states, twenty-two cents; and in the United States, twenty-five cents.

The results show that horse power will be confined to short distances, and the distance will grow shorter and shorter all the while.

This excessively high rate of transportation by horse power will continue to be a burden upon the people, but I have a fixed determination as to the means by which a way will be opened to us to escape that burden.

I hold that the economic gain is so very great by the use of electric power and the means to spread it so within our reach, that we can establish a universal system without the aid of animal power of any kind for transportation.

Nothing has a greater influence upon the people than the means of transportation. Formerly the population was distributed almost equally over the state and over the country, and our highways were laid out with reference to accommodating our population. At frequent intervals villages have been built up, five or six miles being about the greatest distance between them. In these nearly all the articles manufactured and the food products were largely consumed in the vicinity where produced. But that is changed so that now, instead of most of the people

living in the country, one-half have been concentrated in the cities. We should overlook a plain, evident and important fact if we did not consider that one phase of the problem which is to be solved in reference to transportation and highways.

Then seeing that the problem is a great one, seeing the great difficulty which confronts us, seeing that horse power has been in use from generation to generation and from century to century with but little increase in its power, while, when we have departed from that and introduced other power we have been rewarded for our ingenuity more than we have expected, it seems to me we have there the intimation which should give us the course we ought to pursue.

Most of us will yet live to see seventy-five per cent of all the population concentrated in cities and only twenty-five per cent remaining in the agricultural districts. When that has happened, and even when it has gone so far as it now has, the road problem becomes a new and different problem from what it was when the population was distributed more equally throughout the country. This condition has passed, never to return, and this other thing which has been brought about, which has been contributed to more by cheap transportation than anything else is irresistible in its results, and will be going on, going on and going on.

It is our duty to establish roads radiating from these centers of population and bring to the doors of the people, wherever located through the country, better and cheaper means of transportation.

Another thing is the daily delivery of mail. If I am right in my prediction made heretofore in regard to bringing to that class cheap and easy means of transportation, how easy it is to solve the problem of daily delivery of mail, and the establishment of a parcels post.

I think it is clear and all will agree that it is an end of sufficient importance to work for, to assist our friends in the rural districts and their representatives in the government to bring about all these matters.

I do not wish to try to go so fast with any improvement as to leave the people unprovided for. I have a photograph of a new road which I am building in our county. This road, I think, will serve to bridge over the interval, and if I am mistaken in any degree about the final prognosis, in this case there would be no loss from an engineering or economical point of view in building this kind of a road.

It represents a common highway, the iron track and macadam pavement between being so built that vehicles propelled by animals or inanimate power will pass over the same road with equal advantage. It is also so built as to be almost imperishable. The rails are not supported by wooden cross ties or string ties. The rails are about five inches on the side, with flanges running along the outside, and under is cement to hold it to the substructure of stone. The road is dug out and filled to the bottom with broken stone with a top of concrete, and the rail coming on top of that forms practically an iron cap to a stone beam, the whole thing held together with Portland cement with cross ties to prevent spreading.

What I claim for that road is, in the first place, it does not cost more than a stone or brick road; in the second place, it will last many times as long, and in the third place, the same power will move twenty-five times as much as on an ordinary road. An animal now, on an ordinary road, will only move perhaps four times its weight. Upon that level it could move a hundred times its weight, if it could be loaded properly. I do not think it could be put upon one vehicle, but this would be true, figuring that four pounds lateral pressure will move a ton.

You can get this kind of a road built as cheap as any other kind of road, unless you have the material upon the spot, or very near the spot. If it must be moved for any distance, this can be built as cheap as any; for when it comes to moving material, there is where the gain comes. But if you had the roads built for nothing and maintained for nothing, the cost of transportation over the common roads would still be so high that you could not compete with such roads where the cost would be so low as I know it is upon these steel rails and with inanimate power.

I do not know whether I have made myself clear, but I am willing to answer any questions that may be asked. I shall maintain this proposition under all circumstances and will be glad to have your co-operation to help carry it out.

HIGHWAY IMPROVEMENT AND SKETCH OF RECENT PRACTICES IN GREENE COUNTY, OHIO.

G. A. McKAY, XENIA, OHIO.

The present agitation from one end of our land to the other of improving our highways, is one that should engage the attention of our Engineers generally, and, as to the highways of this state, the Engineers of this Society in particular. A vast field is open to the Engineering profession of this country in that direction, and we should lose no time in thoroughly mastering the subject in all of its details.

We have certainly reached the highest point of excellence attainable by our present haphazard and unsystematic methods of construction and maintenance. The reason why our roads are not better is not that the necessary cost is beyond our ability, but is rather due to the lack of well-devised plans for their construction and maintenance. The public is beginning to realize this fact, and naturally turn to the Engineering profession for such services. The public, however, is very slow in learning that in employing an Engineer to draw plans and prepare the work for the contractor, that they lose much of his valuable services by not employing him to superintend the work in all the minor details.

Proper attention to these during the progress of the work will add much to the utility and appearance of the road when completed.

Our present system of road construction grew out of the necessities of the people at the time of its introduction. At that time it was not a question of how many bushels of wheat, corn or other commodities that could be transported to market, but for several months in the year it was almost impossible to get out in any manner, even on horse-back; a journey of ten miles was a tedious and slow one, requiring a full day to go and come. The writer well remembers when a boy of making many such journeys, the hoofs of the horse making a loud report at every withdrawal from the deep mud—even following the zigzag line of a rail fence to find firmer footing. It was under these conditions that the present system of road construction was introduced, and about the only thing considered in planning it was to get something that would lift us out of the mud. These roads were planned, superintended and built by persons with no previous skill or education in that line, following generally the natural contour of the ground, filling over hills and hollows alike, giving little attention to gradients, alignment, drainage or other details of construction. It was under these circumstances that what some writers choose to term our pernicious system of road building and maintenance has grown up.

Instead of criticising too severely past methods of construction, we should study them carefully, find wherein they are defective and apply the remedy.

These roads have been very valuable and worth many times their cost, imperfect as may have been their construction. The people taxed themselves, built these roads themselves, and turned the money largely back into their own pockets, and had both the money and the improvement, which to some extent can be repeated in further improving our roads. The value of improved roads has been so thoroughly demonstrated to the public by the building of these roads, that further improvements are made desirable and possible.

The public is beginning to demand roads with a smoother and more perfect surface, alignment and gradients. A new factor has also arisen in recent years, making demands on our Legislators and road builders for smoother and better roads. I refer to the wheelmen, of which we have many thousands who ride the wheel for both pleasure, and as a means of quick transit from their homes to the shop, or place of business, and will surely use their influence to secure improved roads.

In considering this question we naturally turn toward foreign countries that have excellent and most durable roads for information, but just how far their methods can be successfully and economically introduced into this country is doubtful.

That much of value to the Engineer and those having to deal with this problem can be learned from this source, will not be denied.

The Engineer who plans road improvements in this country, must take into account all the circumstances, probable amount of travel, proximity of materials suitable for the purpose, etc. "Economy must" or should be the first consideration.

The road that will give the most and satisfactory service for a term of years for the least outlay, original cost and interest considered, must be the economical road to construct. For this reason the material in the vicinity, if any suitable for the purpose, should be used. In sections where gravel is procurable within reasonable haul, it is one of the cheapest, and when of a good quality and rather fine, one of the best road coverings we have. Gravel, as found in a natural state, if often too coarse to make a good road without thoroughly raking out the coarser material. This fact has led the writer to advocate passing all gravel mixed with boulders through a stone crusher, especially for top-dressing old, worn roads. The expense would not be very great if elevated bins were used to receive the crushed material, as the time of teams that would be saved in loading would partially compensate for the additional cost. Crushed limestone, when properly prepared and spread, is a good road covering, but hardly superior to a good quality of gravel for durability.

One of the most neglected points in our road construction in the past has been the drainage. The side ditches often being nothing

more than holes along the roadside, standing full of water for several months in the year, sometimes covering the entire road itself for days at a time, rendering the whole foundation and wearing surface one quaking and moving mass every time a load passes over it, especially in the spring of the year when the frost is leaving the ground. The pontoon bridge, if I may so term it, becomes so weak that it breaks and lets us fall through, hence the expression "the bottom has fallen out of the roads?" This condition of our so-called drains is largely responsible for our having to practically re-build many sections of our roads every year or so. The metaling being the heavier material goes down, and the mud and water naturally comes to the top.

When we have learned that we cannot build durable and substantial roads of any kind on a bed constantly yielding and sinking, but when we have rendered the foundation dry and firm by thorough drainage, we will find that any type of grade well crowned will then, with any kind of material, be it gravel, macadam, or even mother earth herself, will make a good road. It was my privilege to spend four years in a country where the roads were thoroughly underdrained naturally, but the sand made them almost impassable except during wet weather, but by spreading a few inches of clay on top, made very passable roads. A clay bank in that country was very valuable on that account.

Where the side ditches to our roads have not sufficient fall or outlet, underdrains should be used, and where the grade of the road is sufficient to cause much wash, bouldered gutters should be constructed. It is confidently believed by the writer that generally, the cost of thorough drainage could be deducted from that of the metaling surface, and yet produce a more durable road; and when we take into consideration the increased cost of maintenance by lack of proper drainage, its cost sinks into insignificance.

GRADIENTS.

The maximum and minimum gradients established or permitted on roads effect their usefulness and cost of maintenance to a very great extent. In rough and hilly sections, the extra cost of transportation, additional cost of repairs, inconvenience and loss of time to the traveling public over steep hills is enormous; on hills of moderate length the cost of reducing the grades to reasonable ones, seldom exceeds the cost of repairs for ten years. It is actual economy in most cases to cut them down, regardless of the advantage and convenience to the public.

On long, steep hills it is generally cheaper to go around than through them. The grade to adopt will depend somewhat on circumstances, the importance of the road, etc., but in no case should it exceed five or five and one-half feet per hundred, even then in soils liable to wash the side drains should be bouldered.

Minimum or level stretches are to be avoided as much as possible on account of the difficulty of securing perfect drainage.

It is also important to bring all roads up to true lines of grade from point to point, making as few changes as possible; this point has been greatly neglected in the past by both the builders of roads and those who have had charge of their maintenance.

Unless we look after this point carefully in the construction and repair of roads, the finished road will be full of little depressions that are hardly perceptible to the casual observer, which permits water to collect and soften the road so much that in a short time it is full of disagreeable ruts and mud holes.

A road properly graded, with the gravel or macadam spread on by one who has the mechanical skill to properly do it, will always be a better road and cost much less for repairs than one built in an indifferent way.

There is always more or less displacement of the material while the road is new by travel, unless thoroughly rolled down; but even then, if the original surface was brought to a true line, it can be made so again by simply scraping up from the sides.

To come now to the latter part of our subject, viz., recent practices in Greene county:

A better understanding will be obtained by first giving a little description of the topography of the country, character of the soil, etc.

The east and southeast part of the county is very level, and originally much of it was very swampy, but has been made very productive by under drainage; the soil being a deep black loam, and some of the lowest depressions are underlaid with gravel of a good quality for road purposes, which is always found from two to four feet under the surface and below the water line, necessitating the constant use of large steam pumps to drain the pit.

The middle and western part of the county is of a rather undulating country, the hills becoming abrupt and steep, bordering on the rivers and water courses, with a deep clay soil on the high lands, and the valleys of a black or sandy loam. In many places good deposits of gravel are found and in several places lime stone suitable for road purposes.

Nearly all the important roads in the county have been more or less improved by grading and graveling in former years, but many of them have become almost worn out and require reconstruction.

In some cases, when the grade of the old road is in a fair condition and satisfactory, the road is repaired by dressing with a good coat of gravel or broken stone on top of the old material. In other cases, the entire road is regraded and remetaled. In most cases, however, only certain sections require regrading, such as low, flat places, or hilly sections that require the hills to be cut down.

In the construction and repair of roads in this county for the past five years, some changes have been made that are believed to be an improvement, at least they seem to be approved by the public, and that is some evidence of their value.

The whole outline and form of cross-section of the finished road-bed has been changed to conform more nearly to that of a well-crowned street, discarding the abrupt and deep ditches so common along our roads. On the inner or next to grade side in all cases when the fill does not exceed two feet, the slope of the ditch is made with a slope of three feet horizontal to one foot vertical, and the roadbed, beginning at the inner edge of the ditch, is made a segment of a circle, crowning about one-half inch per foot toward the center. On this road-bed the wearing surface is spread.

If of gravel, it is laid from twelve to fourteen feet wide, and in the center from twelve to sixteen inches in depth, sloping down to six or eight inches on the edge. If broken stone is used, the depth is made from ten to thirteen inches in the center, including four inches of screenings [such as will pass through one and one-quarter inch meshes in a revolving screen], and sloping down to about five inches on the edge. Before removing the dump boards, enough earth is thrown up against them to hold the material in place after the removal of the boards, until a considerable stretch of road is made in this way, when the shoulder between the ditch and the edge of the metaling is cut off with an ordinary road grader, finishing flush with the edge of the gravel or broken stone, giving the road a gradual and rounded finish, sufficiently steep at any point to insure rapid drainage toward the side ditches, but not steep enough to be a menace to travel, even when forced into the side ditch.

Earthing up the edges in this manner, holds the material in place much better than if left to spread all over the road, and practice has demonstrated that it is no detriment to the drainage of the wearing surface on a well-graded road. Another advantage of this style of road-bed is, that in cases of emergency there is as much room as on a roadway from six to eight feet wider of the ordinary type.

On fills exceeding two feet, where the material is taken from the cuts, the embankments are generally made with the usual slope of one vertical to one and one-half horizontal.

As few changes of grade as possible are made, cutting off small knolls and filling up small depressions in order to maintain uniformity. Changes of any consequence being eased off by vertical curves from two to five hundred feet in length.

Rounding off the grades in this way adds much to the appearance of the road, and is easily accomplished by making a profile on a large scale and taking the elevations directly from it.

In hilly sections of the county, the work of reducing the grades to reasonable ones has been introduced in several townships and is becoming very popular with the people.

Usually the township trustees pay one-half the cost of earth work, and the cost of putting on the gravel or broken stone, and the county one-half the cost of earthwork and the cost of the gravel at the pit or the broken stone at the crusher. The County Commissioners and

the Trustees of the several townships have worked together on these improvements and it has only required introduction in a locality one season to make a clamor for more of it the next. In fact, in some localities large donations in addition to the regular road tax have been made to continue and extend this work.

The maximum grades, except in a few instances, have not exceeded five feet per hundred, and on the more important roads for two years past the grades have not exceeded four and one-half feet per hundred. As this work progresses and the advantage and permanency of such improvements is fully realized by the public, the greater their desire for a reduction of the grades to the lowest possible limit without excessive cost.

In several instances, long and dangerous hills have been improved by constructing a new line of road around them, or by taking advantage of side slopes and making detours in such manner as to make the roads on suitable grades, avoiding deep and long cuts, lessening the liability of slips and slides.

In one instance about one mile of road was changed to avoid four very dangerous railroad crossings, also shortening the road several hundred feet. In all cases the entire line of road to be improved is cross-sectioned and profiled, and plans in detail with estimates of cost are furnished the commissioners and trustees and are approved by them, which plans are carried out as nearly as circumstances will permit.

The drainage of these roads has been accomplished so far, by open ditches along the roadsides with bouldered drains on steep inclines.

In the level sections of the county many of the tile drains of the adjacent lands, running near to or across the roads, assist greatly in their drainage. It has been the practice recently in this county, when planning and fixing the grade lines and specifications for work, to give especial attention to this point, so that the water will flow unobstructed to the natural outlets.

The improvement of our roads to true lines of gradient, alignment and neat finish, add much to the usefulness and appearance of the road and creates a respect and care for the road by the adjacent land owners that they would not otherwise have.

Now, by way of conclusion, I will say that I think the time has come that if we are to have economical and satisfactory roads, they must be constructed under specifications and plans drawn by competent engineers and executed under their immediate supervision and, that the public may have a reasonable assurance of their ability to perform such service, they should be required by law to pass an examination by a board of competent Engineers of the state.

THE IMPROVEMENT OF COUNTY ROADS.

J. F. BROWN, CLEVELAND.

In the development of the material resources of a state, the ease and rapidity with which material and supplies can be transported is an important factor. In a new country, in low, wet territory—that foretaste of future punishment, the corduroy road prevails.

The next step is the construction of immense ditches along the sides of the road often furnishing a place for water to stand and soak away or evaporate.

Next comes the idea of applying some hard material on the surface of the road, generally broken stone roughly placed in position by dumping from carts or wagons, it being expected that the travel will wear the stones smooth and make a solid roadway. Thus far the process is the general one above described, and although expensive and unsatisfactory, has been repeated over and over again. The idea that by thoroughly under-draining the subsoil of the roadbed and using in consequence less material in building the road is very slow in gaining favor. Under the present system it seems that a political "pull" is more efficient in controlling and directing not only the building of improved roads, but in all other county improvements. Almost invariably some friend of a County Commissioner, to whom said Commissioner is indebted for campaign work, is appointed to inspect materials and superintend the construction of county roads. He may be totally ignorant of the work to be required of him, but he is chosen in preference to men of experience and ability. In consequence of this state of things, theory runs wild, experiments are tried, the public money wasted and poor results obtained.

The remarks above written apply also to all public works and in my judgment indicate the impossibilty of securing a prompt and effective system of public work under the direction of Boards of County Commissioners in this state. I would suggest, therefore, that a statement of these facts be presented by the Ohio Society, and a memorial asking that a law be enacted placing all improvements and repair work in this state in the hands of men appointed by the Judges of the Common Pleas Court, to be chosen on account of fitness regardless of political preference.

To the younger class of surveyors or engineers, or to those whose duties have led them to a point where they are likely to take up road improvement work—the following ideas are presented for consideration.

First, last and all the time the disposal of water should receive the care and attention of the engineer in designing a road improvement. More satisfactory service in the use of an improved road can be obtained by the use of 10 inches of road material properly laid and con-

solidated upon a roadway, the subsoil of which is well under-drained, than can two feet of the same material without such drainage. Open ditches will not do the work of under-drainage for the subsoil; they are useful to carry off the surplus of storm water, but there their usefulness ends.

Subsoil drains should be laid with their water line not less than 4 1-2 feet below the crown of the finished roadway; they should not be less than six-inch size; they should never be of soft drain tile, but of second-class sewer pipe, the joints should never be cemented; the trench should be refilled with a porous material all or in part (the more the better). The very best material to be had for refilling trenches is the common black cinders from locomotives, screenings of blast furnace ashes, clean and free from fine white ashes. In case ashes cannot be procured, screened gravel may be used, the finer gravel to surround the pipe. In wet places where running sand or quicksand is found, the pipes should be laid on planks or boards to keep them in line. Broken stone should never be used for refilling trenches where there is any danger of silt washing in to fill the pipes. As an illustration of the carelessness sometimes used in selecting materials, the writer once oberved a street being paved with brick; the foundation was a course of crushed Berea stone, and strange to say the crushed stone was shoveled from the crusher into wagons and put upon the subgrade, screenings and all. The cushion for the pavement was of lake sand, brought a long distance by cars. A proper construction would have been to fork the crushed stone and afterwards to use the screenings for the cushion course. The screenings have hard, angular corners and under pressure forms an excellent ballast. The lake sand is composed of round water-worn pebbles, liable to shift or slide under pressure and not making a good ballast, a much better piece of work could have been done without using the lake sand at all. One other case came under notice of the writer, the conditions of which were as follows: An expensive brick pavement was to be laid upon a street, the subsoil was light sand underlaid with quicksand, to the depth of about six feet to an impervious stratum of blue clay. A drain pipe 24 inches in diameter was laid, the top of the pipe being less than two feet below the bottom of the brick pavement; the joints were cemented and surface water was admitted through catch basins. The pavement was then laid on the sand without any ballast; the result is that the pavement is settling in places and has the appearance of breaking up.

A proper construction would have been to have laid the pipe with the water line at the junction of the sand and the blue clay, leaving the joints not cemented, refilling trench to top with clean black cinders and making catch basin connections for surface water, with cemented joints. This method would have lowered the water line, leaving the ballast and subsoil dry and solid and reducing the danger of settlement of the pavement to a minimum. On the same street an old stone box culvert with an opening of four feet was rebuilt. The new walls were five feet thick and the opening was still four feet. A better plan would

have been to have made the walls 2 1-2 feet thick with an opening of seven feet, thus gaining three feet of waterway for less expense than by the first method.

One example of the ill effects of lack of drainage may be observed in the condition of the street car tracks of the city of Cleveland. The general rule has been to lay the ties upon the subgrade without ballast of any kind. The pavement is then laid on each side and between the tracks and rails. Invariably the tracks settle out of line, the paving stones or bricks are pushed up along the outer rail and a general displacement of track and pavement occurs. To obviate this the companies have substituted long rails 60 feet each, or more, and various other devices—all in vain; the tracks soon become rough again and the company is compelled to relay the track again and the street pavement is ruined once more.

We learn from these few observations that the first requisite on any piece of public work is a thorough system of drainage for surface and subsoil water; to do less than this is to invite a failure in the stability of any structure to be erected upon an insecure foundation.

RANDOM NOTES ON THE CONSTRUCTION OF BRICK PAVEMENTS.

E. A. KEMMLER, COLUMBUS.

I have no new and startling suggestions to offer on the subject of street pavements. However, being connected, as I am, with the engineering staff of a city with 114 miles of improved streets, representing almost every variety of paving material, both natural and artificial, I may be expected to say something about our streets, possibly to hold them up as good examples for the members of this society to follow.

But I shall have very little to say about Columbus streets; they are of all grades of excellence and inferiority, in short, good, bad and indifferent, very largely indifferent. The only advice that I can give as the result of experience in Columbus, is along the line offered by a certain minister, who is said to have admonished a fault-finding member of his congregation, not to do as he (the minister) did, but as he told him to do.

I have studied the specifications for brick streets of a number of the larger cities, and my essay will consist of a review of the salient principles of street construction, as laid down by the different specifications, endeavoring to point out the good and bad features, as I see them, and expecting no one to agree with me in all of my views and opinions, but hoping to provoke a lively discussion for the benefit of all of us who are engaged in superintending street construction.

Among the specifications referred to are those of Buffalo, Cleveland, Cincinnati, Louisville, Kansas City, Mo., Omaha, St. Louis, Detroit, Philadelphia and Providence.

GRADING.

Nearly all specifications are satisfactory in respect to the preparation of the subgrade by rolling and removing spongy material; but only one (Louisville) requires the material in embankment to be rolled and compacted in thin layers, as it should be, for the inherent weakness in all improved streets lies in the possibility of settling.

It may be laid down as a cardinal rule for the entire structure, that every possible chance of settling or movement among the materials must be avoided if the smooth, regular surface of the pavement is to be preserved.

I believe that it would be better to prescribe the weight per inch of the roller, instead of its gross weight, as is done in most cases. I also believe that the horse roller is a relic of barbarism, and ought to be abolished in street work, as it has been in 75 per cent. of the cities con-

sidered. Every city ought to own and operate a roller of its own and charge the contractor a fair price for its use. In Detroit the charge is one cent per square yard of surface.

There are but two steam rollers in this city, one of five tons and the other of about eight tons weight, both owned by contractors.

CURBING.

Two cities require the curb to be bedded on and backed by concrete as it undoubtedly ought to be. All others use sand or gravel, the thickness of the bed varying from 2 to 6 inches. The alignment and grade of curb set in this manner will suffer according to the thickness of the bed, and the number of rains during the work. If sand or gravel must be used the tendency to settle down and shift ought to be reduced to a minimum by making the bed thin, in my opinion not more than two inches.

FOUNDATION OR BALLAST.

Herein lies to the greatest degree, as I believe, the success or failure of a brick pavement. The foundation ought to be as near perfection as to stability and soundness as it is possible to make it. Cleveland and Columbus are the only cities of those considered, which do not use concrete in the foundation; Cleveland probably, because most of the streets are built on a solid rock subgrade, and Columbus on account of its greater cost over other material.

Cleveland uses unscreened gravel or bank sand, puddled; Columbus crushed limestone or limestone bowlders, and bank sand rolled into the upper voids.

In this city an 8-inch gravel foundation can be prepared for 20 cents per square yard; crushed bowlders 25 cents; crushed stone 27 cents; six inches of concrete 55 cents.

It requires no extensive argument to prove the comparative inferiority of both gravel and crushed stone as a foundation material. Neither can be made uniform in hardness and soundness, nor can the constituent elements be prevented from moving among themselves after the pavement is completed.

According to Trautwine crushed stone has from 40 to 50 per cent. voids. When the sand is spread upon and rolled into a stone foundation, perhaps one-half of these voids are filled, principally in the upper layers. Apparently the mixture is compacted into a solid mass, as indicated by its appearance on the surface. But in reality the sand grains are in unstable equilibrium, liable to be disturbed by every impact upon the pavement; readjustments must follow, and the sand has a tendency to work its way to the bottom, its place being filled by the material in the paving bed, and the result is, depressions are formed, which are both unsightly and disastrous to the life of the pavement.

Still another objection will apply to a crushed bowlder foundation. Eighty per cent. of the material used in Columbus under this name consists of pebbles too small to be affected by the crusher. The result

is, there are no sharp, ragged points to give the fragments a hold upon one another, and it fails to pack readily under the roller, unless buried under loamy sand. When the sand wagons come upon it after being rolled, the wheels cut in and destroy to a large extent the work of the roller. I am sure that it would be better for both gravel and stone foundations to require the paving sand to be brought on in wheelbarrows rolled on boards, just as it is done on a concrete foundation.

In order to obtain the best results, I believe that a concrete foundation is essential, especially on avenues having street railway tracks. If you find today in Columbus any brick pavement along street railway tracks in a faultless condition, it is either on account of a special dispensation of Providence or because the railway company has recently made repairs.

PAVING.

The usual manner of bedding the brick is upon a cushion of sand, one to two inches thick, smoothed and shaped to the crown with a wooden template.

I consider the sand cushion the weakest feature of a pavement laid on a concrete foundation, because it is an unstable material and should therefore be as thin as practicable; in my judgment, one inch is sufficient.

All specifications considered require tamping of the brick when laid, and the majority of them rolling in addition, to produce a smooth, finished surface.

Cleveland and Philadelphia use a special block, made with one-eighth inch projection on the vertical sides, to insure open joints for receiving the filling material. The only objection I can see to such a block is that manufacturers will not make it unless it is ordered, and then they cannot supply the block as fast as they are needed.

FILLING THE JOINTS.

For filling the joints Omaha uses bank sand; Cincinnati, Detroit, Louisville and Columbus coal tar pitch numbers 5 and 6; Cleveland and Providence a mixture of coal tar and asphalt; Philadelphia, Brooklyn, Kansas City, St. Louis and Trenton, N. J., a cement grout, composed of equal proportions of lake or river sand and Portland cement.

It seems to me that the office of the filler is twofold, to prevent water from reaching the foundation, and to protect the edges of the brick. In order to meet both of these requirements, every joint should be filled to the top and remain there, wearing down with the brick.

I do not believe that sand fills the requirements, nor have I a high opinion of coal tar as a filler. By using extraordinary care the joints may all be filled by flooding the pavement with the tar at 300 to 400 degrees and sweeping it into the joints, and by going over some portions twice. But on hot summer days the tar melts and flows, follo‑ ing the law of gravitation, and settles in the gutters, forming a b‑

unsightly scale, sometimes as much as an inch thick. The joints, partially deprived of their filling material, become filled with water, mud and ice in turn, and these elements, aided by the impact of the tires of wagons and shoes of horses are fatal, at least to the appearance of a street if not to its life.

I am not familiar with the manner in which filler composed of a mixture of tar and asphalt acts; but the engineer of street construction and maintenance in Brooklyn informed me that as a result of his experience he now prefers a mixture of 80 per cent. coal tar and 20 per cent. refined asphalt to all others.

The grout filler has been used in Columbus with ill results, and was abandoned, the cause of failure being attributed to the filler. It was reasoned that such a pavement, being practically inelastic, expands under summer temperature, sufficient to raise it from the foundation and cause it to act as a series of arches or domes. This claim is certainly substantiated by the hollow, rumbling noise produced by the passage of vehicles over it; the pavement seems to act as a sounding-board for the air between it and the foundation. It is also a fact that such pavements have failed at a number of points, in rectangular patches, sunken bodily as much as four inches in places. Occasional cracks as much as a hundred feet in length can also be found.

But I cannot attribute all of these phenomena to expansion alone. In the first place the majority of streets are paved in summer. The street which in Columbus has shown the largest percentage of failures was commenced in April and completed in August. Then again, expansion does not account for a drop of three or four inches, and nothing but a settlement of the foundation will.

The feature of the grout filler which makes it a desirable material for the purpose, is its preservative effect upon the brick, especially the soft and the overburnt brick. Numerous examples might be given, taken from our streets, to illustrate this point, but I will mention only one.

During the summer of 1892 two streets of almost equal areas, namely Summit street from Warren to Woodruff, and Third street from Fulton to Reinhard, were paved, both with Hallwood block, the former with grout filler, the latter with tar. The cost of the former was $1.90 per square yard, or $47,790 in all, the latter $2.10 per square yard, or $44,365 in all. The travel on Third street is probably a little larger than on Summit street, but it also has a much firmer foundation.

I have made a careful examination of the two streets in order to approximately estimate the amount of repairs necessary to restore them to a fair condition.

Nine hundred square yards of new brick at 90 cents per square yard, or $810, will place Summit street in probably as good condition as any five-year street in the city. But in order to put Third street in as good condition, no less than 6000 square yards of pavement would have to be taken up and relaid with new block at a cost of $5400.

I can trace this great difference to no other point than the filling material, and believe that a hard and permanent filler is necessary to cause the brick to wear instead of chip and go to pieces.

BRICK TESTS.

Buffalo, Kansas City and St. Louis require the brick to undergo certain tests before acceptance.

The St. Louis specifications, which represent the latest knowledge on the subject, are as follows: The brick shall have a modulus of rupture on cross breaking of 2500 pounds per square inch. It shall sustain a loss of not to exceed 30 per cent. of its weight on being subjected to 1800 revolutions in a standard rattler, each sample being tumbled by itself.

The Buffalo method is to tumble the brick with a mixture of scrap and pig iron; the absorption and specific gravity tests are also given considerable weight.

Probably the majority of the members have read the recent report of a paving commission appointed by the National Brick Manufacturers' Association of the United States. Professor Edward Orton of Columbus anu Mr. F. F. Harrington of the St. Louis testing laboratory, are the chief contributors.

I will state briefly, for the benefit of those who have not read the report, the conclusions reached by this commission.

1. The absorption and specific gravity tests are absolutely unreliable and misleading in determining the quality of a brick for street purposes.
2. Crushing and transverse strength bear no fixed relation to the other properties of a brick.
3. The test for abrasion should be the only official test.
4. The only reliable results obtainable from the abrasion test are produced by tumbling each variety of brick alone, without any admixture of other brick, stone or iron.
5. End cut brick are greatly superior to those made with side-cutting machinery.

All of these conclusions are the result of numerous experiments.

The fourth conclusion leads to the question as to whether the comparative wearing qualities of different varieties of brick can be determined by the abrasion test. The numerical results of Professor Orton's experiments, as well as his conclusions expressed in the report, seem to indicate that they cannot. His words are: "A brick can only be expected to give its characteristic rate of wear when tested alone, without the use of any other brick."

Since each variety of brick has, then, its characteristic or peculiar manner of wearing and chipping, it seems to me illogical to specify a certain minimum rate of wear, referring indiscriminately to any kind of brick. It would seem more in keeping with the results obtained to omit the numerical ratio altogether and compare each example of bric' tested with a standard brick of that variety. I believe, however, t'

comparative tests can be successfully made by laying the various standard brick side by side on the same street, so that the conditions for all will be the same, and measuring the actual loss of each from year to year.

MAINTENANCE AND REPAIR.

This is a subject so large in itself as to permit of but a passing consideration in this essay.

All cities require a guarantee from the contractor to keep the street in good repair for one to ten years. How the contractors have kept their faith in other cities I do not know. In Columbus there seems to have been a difference of opinion between the chief engineer and the contractors, as to whether a street needed any repair or not, and the contractors have in all except one case accepted their own views on the subject.

Last spring contractors for about 40 streets were notified to make repairs on their improvements, and a single one responded. All the other streets need repairs badly, but by some hook or crook which goes beyond my comprehension, the contractors have up to this time avoided the fulfillment of their guarantees. I may add that the city now retains 10 per cent. of the improvement and proposes to put its own views into practice hereafter.

Certainly no one will question the necessity of some plan, not only of maintenance, but also of proper attention to the opening of streets by sewer and gas trenches and replacing the material thus removed. In order to secure efficiency, all of this work should be done by the city or under its supervision. Persons securing licenses to tear up a street should be required to make a deposit covering the cost of restoring its pavement. and the balance over and above its actual cost returned to them.

A repair fund for streets is a crying necessity. The contractors' guarantee for five or ten years is too short even if performed faithfully. To turn the street over to the elements is almost criminal, besides being bad business management. Columbus has on its hands 114 miles of improved streets at a cost of $5,000,000, and I doubt if 5 per cent of this amount, or $250,000 expended for repairs would restore all of them to a decent condition.

The question as to who shall pay for the repairs is one which I have no time to discuss here; there is no question in my mind as to who ought to pay a large share of the expense; namely, the users of the streets, owners of all vehicles, including bicycles. The costs ought to be assessed "according to benefits," and they certainly derive the greatest benefits from good streets.

In conclusion I would say that, since many years of life can be added to a street pavement by sound plans and proper execution, and since improved streets are an expensive luxury, it ought constantly to be borne in mind when preparing specifications and plans, that the best street pavement is none too good.

REPORT OF COMMITTEE ON LAND SURVEYING.

C. F. ABERNETHY, CIRCLEVILLE.

Mr. President: As your committee cannot hope to contribute anything new on the theory of land surveying, methods of work, instruments, etc., we shall be content to present to the notice of the society certain problems of field work that we have encountered in our experience, that present features of an unusual character.

In the year 1894 the County Surveyor of Pickaway County, Ohio, was ordered by the Board of Commissioners of said county to survey and establish the lines and corners of all the townships lying west of the Scioto river in said county. This portion of the county as you will remember is in the Virginia Military District, and therefore, not subject to range, township and section restrictions.

This order from the Board of Commissioners was the result of action taken on petitions presented by the Board of Trustees of various townships, stating that the true location of the lines and corners of said townships was unknown, and praying that the same be ascertained and established.

The attention of the board was also called to the fact that for years there had been more or less controversy in certain townships as to the proper precinct in which certain parties should vote, and also as to which township should work certain portions of road and build certain bridges.

The first duty of the surveyor in complying with this order was to secure the necessary data for the field work. And at this point unlooked for difficulties presented themselves. Diligent and thorough search of the records of the various offices of this and the adjoining counties of Ross and Franklin (from which Pickaway county was erected) failed to reveal the slightest evidence of record, original survey or field notes of said lines, with the exception of Muhlenberg township, which was cut out of the townships of Darby, Scioto, Jackson and Monroe several years subsequent to the original forming of the townships. This survey was considered utterly worthless by the surveyor, and was not used in the establishment of the lines. It is here given in full to show the carelessness or incompetency of the surveyor.

"In pursuance of an order of the commissioners of Pickaway county, issued on the 10th day of March, 1831, by Jas. Hedges, A. P. C. and clerk of commissioners, I have surveyed the south and west lines of said township, leaving Widow Van Meter out of said township a short distance from the line. The bearings and distances are represented on th

accompanying plat. From several calculations, taking the lowest as a guide, I find the township to contain 23 1-3 square miles.

"S. H. NESMITH, Surveyor.

"March 22, 1831."

The plat referred to showed simply the outline of the township with bearings and distances marked on the lines, Darby creek and two residences near the south line. It failed to describe corners or to even show in what original survey or on whose land they were located. In fact, there was nothing in description or plat to fix either line or corner at any particular point. The nearest approach to evidence as to location of the lines was the Widow Van Meter's residence, and "a short distance" is not very tangible evidence.

On further investigation the surveyor found that there were no acknowledged corner or line monuments extant.

No record, no field notes, no known corners. What was to be done? After careful study of the question in all its phases the surveyor decided to attempt to locate the lines and corners by (if you will permit the term) traditional evidence. Evidence based on knowledge handed down by the earlier settlers, and which, while lacking the value of direct or recorded evidence, yet would be of great importance in locating points along the lines with a fair degree of accuracy. With this object in view a trip was made over the territory and the testimony of numerous parties taken, principally old settlers whose lands were cut by, or who lived close to the lines, township trustees, road supervisors, etc. This testimony was carefully sifted and compared, and proved extremely satisfactory. It showed that for many years certain points and objects had been recognized as being in the lines, viz.: Tree, stump, original survey corner, farm corner, old building, etc. This evidence was corroborated to a certain extent by the County Map of 1848 and County Atlas of 1871.

The question now was, would these points line up with any degree of certainty and locate the corners in the neighborhood of where they were supposed to be. Securing the necessary corps of assistants the surveyor proceeded to run the lines with all the skill, ability and accuracy at his command, and was more than pleased with the result, the points as located by the evidence ranging with a degree of accuracy surprising. In very few cases were they found to vary more than fifty or sixty feet, and in some cases no correction was made in the random line whatever. when the monuments were set. This in lines of from three to ten miles in length.

The lines were all made perfectly straight and marked by dressed stone monuments set at corners, road crossings and intermediate farm lines where roads were one and a half miles or more apart.

Outline plats of the townships, showing the location of the lines and corners with reference to farm lines, roads and streams, etc., and bearings and distances of lines were prepared by the surveyor and made

a part of his report. This report was approved by the Board of Commissioners and recorded in the auditor's office in a book provided for that purpose.

The lines and corners as established proved perfectly satisfactory to the Board of Trustees and residents in general. The only objection coming from the trustees of Muhlenberg township. They were not satisfied with the location of their south line, claiming that it cut off land through the Darby creek bottoms that rightfully belonged to them. On hearing the objections raised the Board of Commissioners granted the trustees permission to have the line resurveyed and if proven wrong to correct the same. Acting on this permission the trustees called to their assistance a surveyor and re-ran the line, which resulted in fully confirming the former survey.

The aim of this paper is not so much to describe a survey made in an unusual manner as to bring before this convention the question of evidence of the character above described. In what cases and to what extent can it be used? The writer's experience has proven this class of evidence worthy of consideration even where field notes exist, especially in lines of any considerable length. It holds with subtle strength to some monument not mentioned of record, or draws with magnetic force to some object foreign to the field notes, and with stubborn persistency refuses to reconcile itself to well fixed rules and principles of surveying. Establish such a line and ignore the monuments or objects of traditional history and you establish a line that is satisfactory to few if any, and which you doubt yourself, knowing as you do that few old lines of any considerable length were ever run perfectly straight.

Your writer would like to hear this question discussed.

DISCUSSION.

President Innis: Gentlemen, you have heard the report. Have you any remarks? I would like to say, that if Mr. Abernethy will come up to the Auditor of State's office, he can get a description of the survey of every county in Ohio.

Mr. Bowen: While Virginia Military lands are all a matter of record, the townships are not.

President Innis: I have never looked for the townships.

Mr. Renick: Mr. President, in regard to Mr. Abernethy's report, I am the surveyor who was called to re-run the south line of the township. I went through the records at Circleville. I found the survey recorded very incomplete, but what little data I could get tended to corroborate Mr. Abernethy's line. It did not suit some of the parties—it did not suit some of the landowners whose land was cut by that line; but their ideas of it were simply traditional—to use Mr. Abernethy's term—but I guess the township line is pretty nearly correct.

FIELD NOTES AND OFFICE RECORDS.

BY HOSEA PAUL, CLEVELAND.

Every Surveyor and Civil Engineer understands the importance of field notes, and it may be thought that nothing new can be said upon these subjects, but even if it is, it is sometimes desirable to restate old truths.

If it is worth while to make surveys, especially if marks are left, or information given out, it is a matter of common carefulness and prudence to preserve an account of what has been done.

I think we can draw quite a distinction between field notes relating to strictly Civil Engineering purposes and those relating to land surveys; a distinction which relates to time or permanence and to the number of persons interested. We may make surveys and estimates for many kinds of engineering work that in their nature are not matters of permanent concern. There may be grubbing and grading, damming and draining, excavating and exploding, and for all of it, the running of lines, turning of angles, the driving of numerous stakes, the taking of levels and sections, all to be more or less entered up into field books, and from which plans, profiles and sections may be made up.

Now the usual purpose for which all this is done is, first, to determine the manner in which the work shall be done, and secondly, the amount of money that shall be paid for it, or its cost. Once the work is completed, the manner in which it was done may or may not be again considered or reviewed.

For much of this kind of work, there will be no occasion to again refer to the original notes. If changes, alterations or additions are required, new surveys and new notes are presumably necessary, and are generally sufficient without recourse to the old ones.

As to the final estimate, it is something to be carefully and deliberately made at a time when all the details have been considered and executed, and is also subject to the criticisms and close watchfulness of the respective parties in interest—those who pay for the work and those who get the money—to an extent that usually prevents serious error. In other words, when the work is completed and the amount to be paid determined, the incident, from the Engineer's standpoint, is practically closed, and while it is desirable to preserve the field notes, etc., as a matter of precaution in case a re-examination of them should become necessary, the likelihood of their use is merely a remote possibility.

Then again, many field notes are taken merely to have the same information immediately worked up into the form of maps, plans and profiles. These are often of such scale and so full of minute details that the field notes are often mere memoranda that suggest so much

more than they actually represent, that immediate use, while the conditions and surroundings are fresh in the mind, is an indispensable requisite to their being of value.

TOPOGRAPHICAL NOTES.

In topographical surveys, for instance, I have sometimes found it desirable to omit the use of a field book almost altogether, and instead thereof to prepare a full scale plan, and by taking this, or a tracing of it (preferably a paper one for convenience in marking) tacked to a thin board into the field, and plat a great many details directly on the tracing.

This is a good way and often the very best way when the plat is on a relatively small scale, two hundred feet or less per inch. By this method all ordinary details, such as buildings, streams, contours, etc., can be shown as clearly as the scale will admit of and with sufficient precision for a large range of purposes.

There is this to be remembered about topographical work, that its accuracy, precision and fullness is wholly a matter of circumstances. It ranges all the way from a rude sketch drawn with a stick in the sand, by an untrained observer with unskillful hand—from that derived from a glimpse caught from a passing train, to the most careful and elaborate survey made with the most refined methods and perfect instruments of which we can conceive.

But I am not writing a treatise on topographical surveying and must go back to my text.

LAND SURVEY NOTES.

When we come to land surveying, however, the element of permanency comes in. People do not ask for lines to be laid down and marked unless they expect to use them, and what is more to the point, to use them for a long time to come and in such a way that other people are affected by such use.

Hence it is especially important for the surveyor to note exactly what was done and to preserve a record of it indefinitely for his own information and protection. Now if a survey is made that involves the determination of land lines, the surveyor's field book should in the first place clearly distinguish its own work from that of others, and distinguish those monuments, stones, stakes, etc., which he found and used, from those which he laid down and established. I think I can show all this more clearly by showing you a sample page of a field book.

INDEXING NOTES.

Next in importance to making and preserving field notes of surveys, is the obvious corrollary that such field notes be properly arranged and indexed so that they can be quickly and conveniently referred to as occasion arises.

That this work is not done as it should be, arises very largely from the fact that it is of a kind that admits a certain amount of post-

ponement. Because, however, it may be put off, it is too often postponed indefinitely, or at least allowed to lag so far behind that an index is rarely up to date or available to the extent that it should be. What current practice in these matters is, may be easily found by looking around us, by recalling what has occurred in our own practice or fallen directly under our own observation.

First I will describe my father's method. His field notes of surveys in Summit county extend from 1834 until his death in 1870, are still in existence and in constant use. The field books proper are numbered from one up to about one hundred and fifty, and it is of these as distinguished from files, maps, etc., of which I speak. Just when he began to feel that an index would be of help to him I cannot say. Probably he got along without it for many years, but nevertheless he began the work somewhat early in his career. The plan was a twofold one, the first part being simply to write in the front pages of each book a table of contents. I may say further that these field books were by no means of a uniform pattern, but varied very considerably in size, shape and color. These variations were, in this case, wholly accidental, but as I remember such variations were not without some advantages, in that a person constantly using them would readily learn to distinguish them by appearance as well as by number, a circumstance which suggests further possibilities in the way of using books of different appearance for different purposes. The field books were usually consecutive as to time. One was used for different surveys in different localities in the order of time that they were made, until the book was filled up. Occasionally, a considerable survey would occupy all of one of the smaller books.

The second part of the indexing scheme was to have a book for each township. In this would be entered (1) an outline plan of the township, (2) copies of original field notes of township line surveys and of the subdivision into sections, tracts or lots (there is a little of everything of this sort in Summit county; (3) notes from County Surveyors' records, court partitions, etc., platted out on one page, with dates, descriptions, copies of deeds, etc., on page opposite; (4) similar notes made up from field books. It was my father's intention to make such book sufficiently complete that recourse to the original field books would rarely be necessary.

If I call these field books the books of original entry, the township books I might also describe as ledgers posted up to a comparatively recent date, and further than this embodying a good deal of information picked up from other sources.

After my father's death it was found necessary to have a more ready way of access to the contents of the original field books, and a new index was made classifying the same by townships, etc. The next step which seemed to be advantageous, was to procure several dozen field books at one time and devote one at least to each township, and in the case of the city of Akron, using four or five books divided according to locality.

In this way the surveys in the same neighborhood were kept together, thus making it possible to find in a single book what in the old plan might be scattered through a dozen books.

It is needless to say that if you divide up a considerable number of field books according to locality, the problem of indexing is greatly simplified. I have at various times suggested this plan to other surveyors, who have tried it with good results.

I would also suggest that books for strictly engineering and for temporary use be kept separate from the land surveys, and that they be somewhat different in color and appearance and that the numbers assigned to them be not intermixed with those used for the land survey books. But however complete the original classification may be, there will always be some occasion for indexing, and I may remark generally that for almost any kind of indexing the card system is incomparably better than any other.

The old fashioned way was to buy a book and determine the plan and spacing in advance, something that is practically impossible to do with any satisfaction. The great beauty and advantage of the card system is that each entry is on a separate card and is therefore independent of all others. The system is flexible and the order and sequence can be changed as often as desired.

HOW TO SECURE A TOPOGRAPHICAL SURVEY OF THE STATE.

BY PROFESSOR ALBERT A. WRIGHT, OBERLIN, O.

Gentlemen of the Society of Surveyors and Civil Engineers:

The subject which I bring before you this evening is one in which I am deeply interested, both as a citizen of the state, who desires that the public interests of the state should be properly and duly cared for, and as a student of science, who desires that the branches of science in which he is working, should be adequately fostered in the state.

I am especially glad to submit this proposition to you, who are the professional surveyors and engineers of the state, feeling assured that if it meets with your favor, it will have been approved by the most competent body of judgment to which it could be submitted.

The present proposal to move for a topographic survey and map of the state, originated in the State Academy of Sciences a year ago at their meeting in this city. The subject was well discussed and strongly endorsed, and a committee appointed to secure co-operation and action. Correspondence and publication have followed, and it is planned to bring the matter before the legislature at a very early date.

In opening the subject for discussion, it may be well to say, specifically, I use the term "topographic survey" as one which takes account of the elevations and depressions of the surface of the land, as well as its horizontal extent; and which leads to the construction of an accurate map, with contour lines, at convenient intervals, joining points of equal altitude. While ordinary maps only attempt to locate objects according to their latitude and longitude, a topographic map adds to these their elevations above the level of the sea. While ordinary maps deal with only two dimensions of space, the topographic map deals with all three dimensions, and in this aspect is complete. We may call ordinary maps "areal" maps, as they show areas only. Such a survey as is proposed would yield a new and independent areal map of far greater accuracy than any which has yet been produced, for only upon such an accurate map would it be worth while to lay down the levels that are run by careful spirit level surveying.

NO ACCURATE MAP EXISTS.

There has never been any such survey in Ohio. The only organization in the state which has ever borne the name of a survey was the Geological Survey, which devoted all its labors directly to geology. While a topographic survey should logically precede a geological survey, and must precede the final and most accurate delineation of the geological structure of the state, yet at the time when the Geological Survey

was organized, the delay and unknown expense that would be involved in producing a topographic map first were sufficient to cause the proposal for one to be dropped.

I have made inquiry of map publishers both within the state and without the state, as to the existing sources for an accurate map of Ohio. The universal response is that there is nothing satisfactory. Our present maps rest upon scattered land surveys, many of them made a hundred years ago in the face of great difficulties, when the country was unsettled and covered with timber, and when the variations of the magnetic needle were usually disregarded.* There has never been a connected survey of the whole state, reconciling the discrepancies and correcting the errors of the partial, hasty surveys, by any authority, national, state or private. It has sometimes transpired, in re-surveying regions as well settled and cultivated as Ohio or New York, that a town, and its environment, is found to have been placed two or three miles from its real position in latitude and longitude. The map makers say that they put together these limited and unco-ordinated surveys and then use their best judgment in reconciling the discrepancies. So it is the "best judgment" of a man in an office in Chicago that gives our maps their finishing touches, instead of an engineer who has made actual measurement of things as they exist. It is true that there is a chain of most accurate triangles along the shore of Lake Erie, made by the Lake Survey, and marked by permanent monuments. But these have been used, so far, only in making an accurate map of the shore line. Also in the northern part of our coal area and along the Ohio river, some points have been fixed and some elevations marked by the United States Coast and Geodetic Survey. We have thus the beginning of a primary triangulation of the state. What is needed is that these should be extended and applied until we have a map which can be used with confidence, and which will respond to the severest tests that can be put upon it.

VALUE OF CONTOUR LINES.

If now, upon an accurate areal map, the elevations and contour lines could be superposed, there would be added to its value an entire realm of facts which are at present unknown and unrealized by the ordinary citizen. If the scale of the maps were such as to permit the country roads and streams to be designated, as it ought to be, then they would lend themselves to a thousand uses of our every-day life. At a glance one could locate the steeper slopes and the level stretches. The traveler, whether on foot or on wheel, can know the ups and downs of his journey beforehand. The land buyer can bring to book the descriptions of the land seller, seeing for himself what is upland and what is river-bottom, delineated by an authority that is entirely impartial. The engineer can lay out the preliminary profile of his turnpike or electric railway at his office desk, being sure of the correctness of the large points of control; city engineers can calculate the water supply that is

*See Howe's Historical Collections.

tributary to their towns, can know at what levels it can be impounded, and learn by inspection the most economical location of dams, reservoirs and pumping stations. The feasibility of projected ship canals and the comparative merits of different routes can be in great measure settled, without expense. The manufacturer, the miller, the miner, the contractor, can know beforehand the best location for his factory, his mill, his shops and his headquarters. Eventually the geological outcrops can be transferred to the same map in a scheme of colors, the geology explaining the topography and the topography suggesting the geology. Then the sheets will be bearing something like the load of correct information concerning the surface of the state that should be demanded and furnished by an intelligent commonwealth.

SCIENTIFIC USES OF THE MAPS.

But these considerations are largely pecuniary. There are others that are scientific, intellectual and educational, and which will be more highly valued by the thinking citizens of the state. The naturalist has a sore need of topographic maps in all his endeavors to explain the geographical distribution of plants and of animals. In his field excursions, as a mere guide for his trips, they make all the difference between high satisfaction, and regret that he had not a better map; while in explaining and recording the distribution of plants and animals, the topography is a factor which injects itself into his problems at every turn. The geologist who is endeavoring to unwind the history of the preglacial drainage of the state and its relations to modern drainage, has at present to map his own topography; and he has nothing to suggest to him the localities where evidence on critical points might be obtained. Unless he is fortunate enough to see the topography of a locality with his own eyes, he cannot know whether there is any problem deserving study at that point or not. In contrast with this we see Professor Davis of Cambridge taking the elaborate maps of France and Germany, and, in his laboratory, writing with confidence of the episodes in the history of the Meuse and Mosel rivers, leaving scarcely a word or an opinion to be altered when the place is subsequently visited in person. The physicist and the meteorologist are in equal need of a knowledge of altitudes, that they may interpret aright the pressure of the atmosphere and its every varying phenomena. Indeed, one cannot foresee all the benefits that would arise from the survey proposed, for every step forward in exact science is sure to open up and form a basis for unexpected advances in related lines. Our duty is to push forward in faith, being sure that our horizon will be broader from the new position attained.

TRIUMPH OVER NATURE.

As a matter of mere intellectual triumph over nature, the utility of this survey may be urged. Ohio has been settled for over a hundred years, and has become one of the most important commonwealths in the Union. Its interests are diversified. It has enjoyed general prosperity, and in education, in the support of public institutions, and in intelligent

appreciation of the best things, it has an honorable standing. But is it not high time that an intelligent people should construct for themselves, and thus be able to contribute to the world a consistent and complete representation, in three dimensions, of that portion of the earth's surface with which their fortunes are inevitably linked? To subdue, to cultivate, to comprehend, to prepare for man's uses with the utmost refinement this surface which is the most persistent and conspicuous element in the environment of man. should be a task, in the accomplishment of which a worthy sense of satisfaction and triumph may well be indulged.

SHALL OHIO BE BEHIND?

Moreover, if we are to keep our place in the ranks of the more enlightened states and countries, we cannot delay long. Several of our Eastern States, including Massachusetts, Connecticut, Rhode Island and New Jersey, have their topographic maps entirely completed, and are reaping the practical and intellectual benefits of their enterprise. Several others, like New York, Missouri and California, have their maps partly completed, while considerable areas of Western territory have been mapped by the surveying forces of the National Government. A number of our neighboring states to the westward are maturing their plans for such a survey, and ere long Ohio, if she does not move, will seem to be a laggard upon this subject. The European nations have long ago provided themselves with surveys of great elaborateness of detail by government authority. We shall not be leading, but rather following, in our appreciation of the advantages of a correct and complete map—if we enter upon this task at once.

EDUCATIONAL ASPECT.

In one other aspect, the utility of such a map may be urged, and urged with greater force than it could be at any previous epoch. This is the educational aspect. Within a few years past a new vitality has been infused into the subject of geography in all its branches, from the simple forms first given to children, up through physical geography and physiography to dynamic geology, and the origin of surface forms. The "New Geography" differs from the old in looking at surface features—not as dead and fixed forms, but as passing through the stages of growth, maturity, and old age. Every mountain, plain and river valley carries in its structure the record of its birth, decline, and perhaps rejuvenation; always changing, never resting, always pursuing the steps of its evolution, slow though they be. This newer conception of the science, together with the better methods of teaching, which send both teacher and pupil directly to nature, create a necessity for a kind of maps and of literature which do not as yet exist. As the study begins with home geography, every school district must work out a geography for itself which will be different from that of any other district. In order to do this, there is need of certain standards and starting points which a survey of the state would furnish, and there is need of a varied sur

of topographic forms, already mapped and accessible for study, both to teacher and pupil. These must be supplied by the sheets covering other portions of the state or of other states and countries.

The ability to read and interpret a topographic map is almost as foreign to the people of average education today, as is the ability to understand a common map among those who are wholly uneducated. Considerable practice is necessary before one can appreciate comparative altitudes, or image in one's mind the profile of a slope, from the contour lines of a map. It is like the study of solid geometry and it requires the command of the imagination in a constructive process of some complexity, but still not difficult. The ability to read such a map is of great advantage to any mind. To represent topography in solid models or raised maps is an expensive and tedious task. The cheapest and most available way of presenting topography is upon maps with contour lines; and it is not too much to say that every school boy should have practice in the use of such maps.

PLANS FOR A SURVEY.

But, however desirable a topographic survey may seem to us, we shall not be discussing the subject to any purpose until some practical plan is proposed of making the survey, and its cost considered. How can we obtain a topographic survey of the state of Ohio?

Three different methods of procedure may be mentioned, in which the cost would vary with the method pursued. I will mention them in the probable order of their expensiveness. The first method suggested would be that of utilizing the various railroad profiles that cross the state in every direction, as a basis for altitudes, and working from these with the aneroid barometer for the intermediate country. The contour lines for altitude could thus be obtained. For the areal map, upon which these lines should be laid down, we might use the best existing maps of the state and of the separate counties, or the best that could be made by new compilations, without resorting to a triangulation survey. This would undoubtedly be the least expensive system that could be devised. It is the method resorted to by the state of Illinois shortly prior to the Columbian Exposition, to obtain the data for a raised map or plaster model of the state for exhibition in 1893.

A second method would be for the state to co-operate with the topographic division of the United States Geological Survey of Washington, the work being done by their experienced engineers. Upon this plan there would be a primary triangulation survey, covering the entire state with large triangles. The smaller areas would be worked out with the plane table and other processes, the result being an entirely new and independent areal map of the state as it is. The hydrographic division would give especial attention to the correct representation of the streams and drainage of the state, while a third division would give the elevations, these being taken entirely by surveyor's level, and nothing being left to the shifting barometer. The maps resulting from this survey would be in harmony with a plan already well inaugurated by the Unit-

ed States survey, of eventually covering the whole country with a good topographic survey preparatory to a complete geological survey. Over 600 topographic sheets have already been issued, each sheet covering a quarter of a degree square, or some multiple of this area. The United States survey will place its topographers in those states where co-operation is offered, they themselves bearing half the expense of the survey, while the state contributes the other half.

This kind of a survey would be vastly more accurate and valuable than the railroad and barometer survey, and would cost somewhat more. But it would cost the State only half the actual expense of the field work.

A third method would be to organize a state topographical survey, for the purpose of making a map, of such a degree of elaborateness as might be agreed upon. It ought to be nothing less than a trigonometric and spirit level survey, resulting in an entirely new and authoritative areal map as well as altitude map. It might be made upon a larger scale and with more detail than the one which the geological survey would propose, but their proposal would be such a great advance upon anything now in existence that the state would not be likely to support anything more elaborate. The comparative merits of the second and third methods may be judged by proposing that they should both undertake to produce the same map. Which of the two could produce the map at the least expense? There is at present no bureau under the state government which is equipped for such an undertaking. It would be necessary, therefore, to organize one anew if the state should undertake the work. New instruments, offices and equipments of every kind would have to be provided, a corps of engineers appointed, organized and trained, and all the preliminary questions as to methods of procedure and methods of publication discussed and settled before the beginning of the efficient work. Unquestionably, Ohio engineers, if granted sufficient time and sufficiently ample facilities, could produce as excellent work as any. But the United States engineers, on the other hand, are already equipped and in efficient working order. Considering these facts, it has been estimated by careful experts that it would cost the state of Ohio three times as much to produce a map as it would the United States Geological Survey. And since the National Survey would be willing to bear half the actual expense, it would cost the state only one-sixth as much, to co-operate, as to proceed independently.

Of the three methods, therefore, there would seem to be no question that the adoption of the second, i. e., of co-operation, would give the best results for the money expended; and it would seem that all consideration of the subject of a topographical map at the present time ought to be concentrated upon this one plan.

RESULTS IN OTHER STATES.

The results of state co-operation with the United States Survey have been very satisfactory in the states where it has been tried. New Jersey was the first state to complete her work in this manner, and it

has already become classic ground in the advanced study of topographic forms and their development. Every school district in the state has been supplied with a full set of the maps, both topographic and geologic. In Massachusetts, Professor Shaler, of Harvard University, who was one of the promoters of co-operation, says: "The most effective point was that the maps would be of great use in the schools. The next most important was that they would afford the basis for farther enlargement, which would lead in the end to a codastral system, i. e., maps which are fit for the uses of the tax assessors, and some of the maps have already been of much service in that regard. By co-operation we got a better map and got it sooner than we could possibly have obtained it in any other way."

In Connecticut, Professor Brewer, of Yale, who was one of the state commissioners, says: "The map has been very satisfactory; is used for a great variety of interests. The Geological Survey did its work well, very well as a whole, although the sheets are of unequal excellence." The expenditure was somewhat less per square mile in Connecticut than in Massachusetts."

In contrast with these satisfactory results in the states mentioned, we may note how the lack of a topographic map in Ohio has entailed losses upon the promoters of large enterprises.

Within a few years citizens of Pennsylvania have spent $48,000 in a preliminary survey for a ship canal between Pittsburg and Lake Erie. Ten thousand of this was spent upon a route which is now definitely abandoned, as a better path has been found through Mahoning county in Ohio, where the summit level is 182 feet lower than in the one first contemplated. If both states had possessed topographic maps, every possible level could have been known at the start.

In response to inquiries Mr. Walcott, the Director of the United States Survey, has kindly written out in some detail suggestions and estimates for a survey of Ohio, and the course that matters would be likely to take can best be learned by noting his statements. He says:

"In view of the highly cultivated condition of the state and the density of its population, I am of the opinion that, if a fixed scale be deemed best for the whole state, that scale be the same as is or was employed in mapping New York, Pennsylvania and the New England states, viz: approximating one mile to the inch, with a contour interval of twenty feet. Such a scale will be decidedly the most satisfactory, from a topographic point of view, and the resulting map will be much more satisfactory for engineering purposes and as a general base and guide map for all purposes. It is sufficiently large to admit of the representation of all the numerous cultural features which will have to be shown. If, on the other hand, it is desired to economize, a scale of two miles to the inch may be employed, but the relief is so slight that the contour intervals should still be twenty feet. To make such a map will cost but little less than to make the former, because the chief cost will be incident to obtaining the vertical relief contours; yet a saving of about $2 per square mile may be made by employing this scale. In this event it would still be necessary, in my opinion,

to map the atlas sheets containing the larger cities, those say containing over 50,000 inhabitants, on the larger scale, employing the smaller and cheaper scale for the remainder of the area.

"The state of Ohio contains 40,760 square miles, most of which is well inhabited and fairly clear of timber, and well cut up with roads, so that its survey will not be especially difficult. Practically none of this area has yet been mapped, nor is there in existence any map material other than elevations along railway and canal lines which will aid in the preparation of the topographic maps.

"The survey of 40,000 square miles on a scale of one mile to the inch, with twenty-foot contours, and including the running of the necessary primary level lines, will cost between $8 and $9 per square mile for the whole state, provided money be forthcoming in sufficiently large amounts to enable the work to be conducted in the most economic manner, say at a total rate of expenditure of $20,000 per annum, or a total maximum cost for topography of $360,000. In addition the prosecution of the primary triangulation over this area will cost at least $1 per mile, perhaps a little more. Say for this $40,000, provided funds for this work be forthcoming at the rate of not less than $5000 per annum. Accordingly the total cost of mapping the state, including triangulation, will average $10 per square mile and amount to $400,000.

"The state of Massachusetts was mapped at an average cost of $12 per square mile; Connecticut at about $10.50 per square mile. This organization has agreed to map New York state for $10 per square mile. The work has progressed at that rate for the past four or five years, but owing to the introduction of more careful spirit level work it will cost henceforth a little more. The state of Ohio could probably be mapped for $7 per square mile, but owing to the total lack of primary triangulation, which was almost complete throughout the areas of New York and New England, and owing to the necessity of doing better spirit level work than was formerly done, I am of the opinion that the figures above given will be very close to the truth.

"Estimating the total cost of the survey to be $400,000 the state would have to appropriate $200,000. If this sum were appropriated most advantageously, it would be at the rate of $25,000 per annum, or $50,000 per legislative session. This organization would appropriate a like amount, the total annual expenditure being $50,000. At a rate of survey corresponding with this, eight years would be required for the completion of the mapping of the state. Lesser biennial appropriations would prolong the time of survey proportionately and increase the cost a little.

"The map would cost the state $5 per square mile, and for this relatively small outlay the state will receive an accurate topographic map of its entire area on a scale and at a contour interval sufficiently large to represent all its cultural and topographic features. This map will show the surface relief for every twenty feet of vertical height. It will show the direction and position of all streams, ponds, lakes and swamps. It will show all roads, public and private, and all houses in

their true position and in such manner as to indicate their relation, not only to each other, but to the drainage system and to the hills, valleys and slopes of the state. It will also show the outlines and extent of all wooded areas. As permanent monuments of this survey, there will also be left all over the country so mapped, copper bolts or plugs, marking exactly the geodetic positions of primary triangulation points. These will be at distances apart not greater than twenty miles, and will serve as initial points for the conduct of all future surveys of every kind. There will be left copper bolts or tablets at points six miles apart throughout the entire state, marking the elevation of these points above sea level to the smallest fraction of a foot. These will serve as datum points for the prosecution of further spirit level work for all engineering investigations and for such public works as canals and municipal water supply, or for railways or other private or semi-private surveys. At every county seat two permanent monuments will be established showing the true meridian, by which surveyors can test and regulate their needles.

"As acknowledged by the state engineer of New York, and by other authorities who have co-operated with this survey, their states could not, and I am confident that Ohio could not, duplicate such a survey for two or three times the cost at which it can be prosecuted by the well organized and well disciplined force of the Geological Survey. It would probably cost the state to map its territory alone $30 per square mile, against $5 by the other plan. Moreover, the state will have these maps engraved by the government (a most important item) free of cost, as they will be engraved by the Geological Survey. Furthermore, when these maps are completed they will be put to the primary use designed by the government, namely, as base maps upon which to represent surface and economic geology. The state will thus come into possession of a set of geological maps at no further cost to it than one-half the cost of the topographic survey. Still another benefit which will accrue to the state by having this survey made in co-operation with the Geological Survey is that a great mass of information will be gathered in the course of the map-making relative to the drainage and water supply of the various streams, both through the topographic and hydrographic branches of this survey; and this information will be of inestimable value to all who are engaged in the utilization of the water resources of the state, either for domestic consumption, the supply of canals, or the production of power for water supplies. The state of Maine considers this feature of the topographic survey alone as warranting the expenditure; as does also the state of New York, in connection with water supplies for its canals, and in making compensation to mill owners for water diverted from them for state uses.

"I would suggest that bills be introduced biennially in the legislature, similar to those passed by the state of New York, and carrying sufficient appropriation to continue the work from one session of the state legislature to the next. This should be expended either through a commission, as in Massachusetts and Connecticut, called a State

Topographic Survey Commission, or better still, be expended through one individual or office, as in the case of New York, which is represented by the state engineer and surveyor. The state representative is generally empowered to examine the reports, accounts and field work in connection with the Geological Survey, and if at any time he finds the work is not being done in accordance with the agreement, he may terminate it."

In addition to these details concerning a plan of survey, the director has answered some questions as to what classes of persons have been benefited by the maps and have sought them for use. He says:

"From Massachusetts we have received numerous appeals from educational institutions requesting maps for school purposes. Engineers and projectors of public enterprises and those interested in hydrography and sanitation apply for the maps to study topography, water supply and drainage. Those having large realty interests also endeavor to obtain the maps to locate thereon their landed estates. Of recent years a constant and growing demand has been made by bicyclers. The requests originating from Rhode Island are of a general nature, but have not left an impression of any special or distinctive characteristic.

"From Connecticut we receive letters similar to those received from Massachusetts, with the addition of that influence caused by the suburban interest of New York City.

"In New Jersey the requests are varied, railroad and farming sharing equal portions of the interest of the applicants. These states are, however, all included in a thickly settled region of advanced development. But from other states where the best existing ordinary maps are few, being compilations from various sources and records, there originates another class of applications. The home seeker, mining prospector, railroad and irrigation engineers, investment companies and all of the many followings of commercial life are numbered among those who appeal to the government for maps."

The sheets composing the map of Ohio would doubtless be issued in uniformity with the sheets covering New England, each being about 17 by 21 inches in size, and printed in three colors, the streams and bodies of water in blue, the contour lines of elevation in brown, and the works of man, or "cultural" portion, such as roads, houses, towns and political divisions, in black. Each sheet would have a name from its principal town, as the "Columbus" sheet, the "Lorain" sheet, etc. The sheets could be kept separate in a portfolio for use singly, or they couold be bound into a thin atlas.

These details of information, furnished by the director, place the project before us in a very definite form. The nature, the quality and the expense of the work can be certainly known beforehand.

ACTION AT THE PRESENT TIME.

The question of inaugurating topographical work in Ohio has been exploited before without success. Twenty-five and thirty years ago it was a frequent subject of appeal by Col. Cyrus Whittlesey of Cleveland,

in connection with the development of the coal seams of the northwestern portion of the state. Later, in connection with the state geological survey, the needs of such a survey were urged, but its claims seemed not to be appreciated by the legislature. During these years of waiting, however, the national survey has been developing remarkable strength and acquiring most valuable experience, both by its tentative and by its completed work. And now the opportunity is afforded us, through their cooperation, of obtaining a topographic map, executed upon such a scale and plan, reaching such a degree of quality, and upon such a scale of expenditure as has commended itself to the judgment and experience of the most important states lying to the east of us. Is there any wiser, more economical, more business-like way of obtaining such a survey? The entire cost of $200,000 is no more than has been repeatedly and properly expended in the erection of a single building for some of our public state institutions. It is less than one-third of the amount which was recently given by Mr. Rockefeller for extending and beautifying the park system of Cleveland, a city in which he had formerly resided.

A bill to authorize the beginning of a survey upon this plan has today been introduced in the senate by Senator Garfield. It will go to the committee on geology, mines and mining, and a special hearing before that committee, probably in connection with the finance committee and the corresponding committees of the house, at which meeting Mr. Walcott has offered to be present, will probably be held in about ten days.

The difficulties which the bill will encounter are principally two: First, a lack of understanding of the nature and uses of the maps so that they will seem fanciful luxuries rather than necessities; and second. the disinclination to inaugurate new expenditures. Whatever can be done by us, either as organized bodies or as individuals, to get the subject well before the legislature, will be well expended effort. A short printed statement of what is proposed has been sent already to each member of the legislature with a personal letter. It would help the matter if they would hear from their constituents. In conclusion I would say that:

The benefits of a topographic survey would be distributed to every part of the state, to every square mile of its area and to every citizen within its limits, ministering to his physical and intellectual advantage, and prompting him to enterprises of public importance. To undertake it is a duty which all owe to all, and the legislature in providing for it would merely be recognizing the obligation which the commonwealth owes to itself and to the world.

SEWAGE DISPOSAL AT ALLIANCE, OHIO.

O. W. PFOUTS, ALLIANCE, OHIO.

It is intended in this paper to consider the Sewage Disposal Plant as built and operated by the city of Alliance, Ohio, and for convenience to both the author and the auditors, the subject matter has been considered under the following headings:

First—Why the plant was constructed.
Second—What the plant consists of.
Third—What the plant does.
Fourth—How the plant does it.
Fifth—What it cost to construct.
Sixth—What it cost to operate.
Seventh—Comments.

WHY THE PLANT WAS CONSTRUCTED.

The city of Alliance, several years ago, realizing the necessity of better sanitary conditions, took up the question of sewers as being a step in the desired direction, and after careful consideration, decided to build a system of sanitary sewers.

It is not intended in this paper to follow up the several steps taken in this matter, excepting in a general way.

The city realizing the situation, secured the services of a competent engineer to prepare plans and estimates of cost of a sewer system. After a careful consideration of the engineer's recommendations and report, the City Council decided to adopt what is known as the separate system of sanitary sewers. Detailed plans and estimates were made and adopted and construction was commenced. Trunk sewer No. 1, East Side Main No. 2, West Side Main No. 3, Low Level Sewer No. 4 and lateral sewers Nos. 10-11-12-19 and 27 were rapidly built, and Alliance was on a fair way to enjoy better sanitary conditions, when, one day about this time, some wideawake citizen living below the city and along the Mahoning river, in which stream Trunk Sewer No. 1 discharged, discovered that the city intended to admit raw sewage into the river. Like every good citizen, under like circumstances, should do, this gentleman began an investigation, we might call it an agitation in this case. The crusade was prosecuted so vigorously that during the summer of 1895 the Judge of Common Pleas of Stark County, Ohio, was convinced, that beyond a reasonable doubt, the city of Alliance, Ohio, would, if permitted to continue in its course, create and maintain a nuisance by virtue of emptying the contents of the city sewers into the Mahoning river, and that the city was violating a statute under which the Ohio State Board of Health operates. And consequently this same judge, at the instance of this wideawake citizen, caused injunction papers to be served upon the city of Alliance, restraining said city from allowing its sewage to

enter the Mahoning river. At this time the city had built 20,687 feet of sanitary sewers, together with man holes and flush tanks, and had expended in the construction of these sewers, $21,758.75. The injunction did not only restrain the city from allowing sewage to enter the river, but indirectly it reverted to the people, and no one was allowed to connect with the sanitary sewers. This second effect of the injunction became a cause, and its effect was to restrain the city from collecting the special assessments on abutting property to the lateral sewers, for the payment of the bonds issued, so that it became necessary to refund the bonds, they running for 1-2 and 3 years, and being payable in three annual payments.

It was to overcome these difficulties that the city council decided to construct a sewage disposal plant.

WHAT THE PLANT CONSISTS OF.

Again the engineer's services were sought, and after due time plans that had been submitted to the State Board of Health and had received that board's approval, were adopted. Construction was begun during the autumn of 1895. Much water was encountered in excavating for the foundations, wells and tanks. So much that it became necessary to install a pumping plant. A 4-inch centrifugal pump was kept running day and night to keep the works from being flooded. After the foundations had been laid and walls partially constructed, a freshet caused the river to flood the works, and freezing weather coming on it became impossible to proceed with the work until spring weather set in; at which time the work was continued, and on July 1, 1896, the plant was completed and put in operation, and has been in continuous operation since that time.

The plant was designed and built for the purpose of purifying house sewage by means of chemical precipitation, and is located on a two-acre tract of land on the north side of Keystone street and extending to the Mahoning river.

The plant consists of the following:

Three precipitation tanks, 40x80 feet each; walls built of brick laid in German Portland cement, 30 inches thick, with a 3-inch stone coping to protect them against the weather. The bottoms of the tanks are slightly hopper shaped, built of brick set on edge on a 6-inch concrete foundation. After the brick bottoms were laid, all joints were completely filled with a Portland cement grout, mixed neat and applied in two coats. The tanks are well and substantially built, and when filled contain about six feet of sewage, or 144,000 gallons each. The tanks are arranged three in a row and cover a space of approximately 80x120 feet. Along the west ends of these three tanks is arranged a circulating channel, 8 feet wide. In this channel and the ends of the tanks are arranged the flash board gates, by means of which the inflowing sewage is admitted to or cut off from any tank, as the operator chooses. At the south end of this circulating channel is the inlet channel, into which the sewage from trunk sewer No. 1 empties, and in which the chemicals are added and mixed with the new sewage.

At the north end of the circulating channel a series of stone steps is arranged, over which the effluent pours and is thence carried by a sewer and emptied into the Mahoning river.

Underneath the concrete foundations of the bottoms are arranged the clear water and sludge drains. The clear water drain is of 12-inch pipe and is connected to the tanks by means of a 10-inch gate valve, a flexible joint and floating skimmer pipe, by means of which valve and pipe the clear water is drained off from the surface (at times when the tanks are being emptied) and admitted to the clear water drain. This clear water drain is arranged with two outlets, one is to the north and directly into the Mahoning river; the other is to the south, and into the clear water well. The reason for these two outlets to the clear water drain is this: The precipitation tanks are of necessity located very low, and during the dry weather flow of the river their bottoms are slightly above the water level in the river, but during all freshets the water surface in the river is above the bottoms of the tanks, and consequently they cannot be entirely drained into the river. Then during dry weather, when it becomes necessary to empty a tank, the clear water is allowed to flow through the floating skimmer pipe and valve into the clear water drain, and thence into the river. But when the water in the river rises, the clear water is delivered by the same floating skimmer pipe and valve into the clear water drain, and thence into the clear water well.

The sludge drain of 15-inch pipe is arranged alongside of and parallel to the clear water drain under the tank, but has but one discharge, that being into the sludge well. After the clear water has been drained off of the tank which is to be emptied, the clear water valve is closed and a 12-inch compression valve, located on the lowest point of the hopper-shaped bottom, is opened. This valve connects the tank with the sludge drain. The sludge enters this drain and is carried and deposited in the sludge well. The clear water and sludge wells are located south of the precipitation tanks, between the tanks and the building. They are built of brick, with 17-inch walls and are fifteen feet deep. The clear water well is eight feet in diameter and the sludge well is twelve feet in diameter. The building is of brick, with stone trimmings. There is also a smoke stack of the same material, 65 feet high, and built to correspond with the building. The building consists of a machinery room 30x36 feet. This room is ceiled with narrow, beaded, hemlock ceiling, the floor is of concrete, four inches thick on a gravel foundation, and is surfaced with a 1-2-inch coat of cement. Through the middle of this room from north to south, extends the inlet channel, thirty inches wide, through which channel the sewage enters the tanks. Chemicals are admitted to the raw sewage in this inlet channel. The inlet channel is covered with a 2-inch plank flooring, let into the cement floor by angle irons so as to present an even surface with the cement floor.

Above this machinery room and on the second floor, is a chemical storage and slacking room, 30x36 feet, with a double thickness pine

floor. This floor is substantially supported from the roof trusses by means of iron roads. As the chemicals are delivered on this second floor by teams and are then stored, this support from the roof truss is a wise precaution. These roof trusses also support a plank water tank, 4 1-2x6x12 feet, which tank affords storage of water to be used in chemical slacking and mixing, boiler feeding and all other purposes about the works. The roof of the two-story portion of the building is of slate on matched pine sheeting. All trusses and timber are mill dressed.

The boiler room is east of the machinery room, 20x32 feet; has a hard burned brick floor, brick set on edge on a gravel foundation, well rammed into place and thoroughly grouted with cement grout, applied in two coats. The boiler room roof is of iron. In the rear of the boiler room are located the coal bins, with a capacity of about 50 tons. The bins are built and arched with brick with manholes in the tops through which the coal is dumped.

The interior surfaces of all brick walls of the building are finished with a cement wash applied in two coats. This cement is mixed neat and as thick as could be applied with a brush evenly.

On the south side of the building is arranged the driveway, leading into the chemical room or over the coal bins. All coal and chemicals are thus handled with a minimum of labor.

In the boiler room is located a boiler of the tubular type, forty-eight inches in diameter and twelve feet long, set up in a full arch front brick setting. The boiler is built of best flange, open-hearth, homogeneous steel plate; shell being 5-16 inches thick and heads being 3-8-inches thick, the dome twenty-four inches in diameter and twenty-four inches high, built of steel of the same thickness; shell and head as the body of the boiler. Longitudinal seams are all double riveted and round-about seams single riveted. The boiler contains thirty-four 4-inch tubes and has a nominal capacity of forty horse power.

All water columns, gauges, cocks and valves, together with all water and steam piping, are furnished with the boiler and in the smoke connection to the chimney the proper dampers are arranged in such a manner as to be operated from the front of the boiler. The boiler is fed with a boiler feed pump. This being a 5 1-2x3 1-2x5-inch horizontal duplex pump. There is also 3-4-inch injector provided.

The boiler feed pump takes suction from the clear water well, and delivers either into the overhead tank above the second floor or directly into the boiler. Direct connection can be made with hose for washing or sprinkling purposes. The water pipes are so arranged that clear water can be delivered to the chemical slacking vats, the chemical mixers, the filter press, the sludge pump and for priming the centrifugal pump; or for washing and sprinkling with a hose.

Steam is delivered into the engine and machinery room to a twelve horsepower vertical engine, used in mixing the chemicals, to the engine of a direct-connected, 4-inch centrifugal pump and to the sludge pump.

Steam is also used in heating the building.

The engine is located over the inlet channel, upon a 6-inch stone setting and is so arranged that all drips and escapes discharge into the inlet valve. The power is transmitted by belt from the vertical engine to a 2 7-16-inch steel line shafting, suspended on neat and substantial hangers from the ceiling. On this line shaft is located two 18-inch pulleys, engaging to the shaft by means of friction clutches. These pulleys are connected to the chemical mixers by means of belts, and can be thrown in or out of use instantly and without stopping the engine, at the will of the operator.

The chemical mixers are two in number, built of wrought iron, five feet in diameter and six feet deep. They are built of 1-4-inch plates thoroughly riveted together, with a 2 1-2x2 1-2x3-8-inch angle iron at the bottom. Around the top of the mixers and on the outside is a 2 1-2x3 1-2x3-8-inch angle iron for the purpose of stiffening the top of the mixers. The mixers are provided with a 2 7-16-inch steel shaft, resting in a shoe journal at the center of the bottom of the mixer and passing through a box at the top of the mixer. This box being supported by iron cross pieces bolted to the angle iron at the top. On this shaft the beater arms are arranged. Above the top of the mixers and on the end of this shaft is located a 24-inch pulley, which being connected by belt to the line shafting as before mentioned, enables the mixers to run at about the rate of twenty revolutions per minute. The mixers are each driven by a 7-inch, 4-ply rubber belt. These mixers are arranged along the west side of the inlet channel in the machinery room, being set on 10x6-inch oak timbers, resting on the cement floor.

The slacked chemicals are admitted from the slacking tanks through 2 1-2-inch pipes and valves, and while being mixed are discharged into a pan over the inlet channel through 2 1-2-inch pipes and valves. This pan has a serrated edge along the one side over which the chemicals pour into the raw sewage, flowing in the inlet channel. Water pipes from the overhead tank discharges through valves into these mixers.

The centrifugal pump stands in the northeast corner of the machinery room and is used for the purpose of emptying the clear water well. It discharges into the sewer located along the west side of the building. This pump was made necessary by the fact that the tanks cannot be drained into the river during the freshets, but must be emptied into the clear water wells.

The sludge forcing pump is a 7 1-2x5x10-inch horizontal duplex pump. built similar to an ordinary horizontal duplex pump, with the exception that it has a double set of rubber ball valves above the plungers. This pump takes suction through a 4-inch pipe and valve from the sludge well, and delivers into the filter press through a 3-inch pipe and valve, and with a steam pressure of 70 pounds can develop a pressure of 140 pounds in the filter press.

The sludge pump is also connected to the clear water well with a 4-inch suction pipe and valves, and can discharge into the inlet channel or by pipes into the overhead tank or into the boiler. All drips and escapes are arranged to discharge into the inlet channel. The pump is provided with all necessary hand holes by means of which the valves can be readily examined.

The sludge forcing pump is located along the east side of the machinery room.

The filter press is located over the inlet channel in the north end of the room. It contains 50 chambers, each being 2 1-2 inches thick at the rim. These chambers when filled make a cake of pressed material about twenty-eight inches in diameter and 1 1-2 inches thick. The press has strong cast-iron heads and supports and steel side bars of about 1x6-inches section. The tightening screw is four inches in diameter and is provided with a quick-acting tightening block and head which allows a longitudinal motion to the breach of about eighteen inches and can be manipulated by one man.

The chambers are so designed that they decrease in thickness from the rim to the center. Each chamber is provided with a brass drip cock at the bottom through which the exuded water drains. There are annular grooves on the faces of the chambers about 3-8-inches in depth, and they are located so closely together, about 3-8-inches, that the entire faces of the chambers are corrugated. These annular corrugations are all crossed with several radical corrugations leading to the drip cock. The central opening in each chamber is five inches in diameter.

The press is fitted with tightening screws and clips, by means of which the filter cloths are held in place. A 1-2-inch rubber gasket is set in the edge of each chamber so as to secure a tight joint without injuring the filter cloths by them coming in contact with the sharp edges of the chambers.

For the purpose of tightening the chambers the screw has a pilot well forty-five inches in diameter and with eight handles extending eight inches beyond its rim, by means of which the screw is turned and tightened or loosened. The entrance head is provided with an air chamber of cast iron, ten inches in diameter at its thickest part and twenty-four inches long. To the upper end of this air chamber is attached a pressure gauge graduated to 150 pounds.

The press is supported on six cast iron legs. These are arranged three along each side and are thirty-six inches in the clear. The bottom of the press is forty-eight inches above the floor. The sludge is admitted through the entrance head and into the press by means of a 2 1-2-inch safety appliance. A 2-inch pipe leads from the supply pipe back to the sludge well. In the sludge well and over the end of this pipe is provided a safety valve, so that in case of any clogging in the press and a consequent rapid increase of pressure in the supply pipe, this pressure can be relieved through this relief pipe and safety valve.

The water which is filtered from the sludge in the press, drains from the drip cock into a channel underneath the press in the cement

floor, and is thence carried by this channel into the inlet channel and again through the works. An iron track is built in the cement floor and extends under the filter press. This track leads out of the building to the east; is carried across the small stream flowing through the grounds on a wooden bridge of 20-foot span and to the dumping grounds. A car large enough to contain one press full of sludge is provided. This car can be run under the filter press. And at such times as the press is to be emptied the car is placed in position and the sludge cakes dropped directly from the press into the car. The car is hauled to the dumping ground and dumped by the men who operate the plant. The entire plant is built in a neat and substantial manner, and in all parts is so arranged that the works can be maintained at a moderate expense. Every arrangement has been made for the efficient operation of the plant.

WHAT THE PLANT DOES.

The amount of sewage flowing into the works during the year 1897 has averaged about 300,000 gallons daily. A great portion of this discharge is water which leaks into Low Level Sewer No. 4, built in 1894. This is a 15-inch sewer; is 4044 feet long, and for its entire length is laid in a water-bearing strata. There is, in fact, a large area of territory in the eastern portion of the city, through which this sewer is constructed, that is so thoroughly filled with water that a flowing well can be constructed at almost any point by simply driving a pipe into the ground. During the construction of this sewer, one change in its course was made necessary on account of the great quantity of ground water. While these natural conditions are no valid excuse for a leaky sewer, the result of constructing such a leaky sewer in such a locality must ever remain the same, that is in disposing of the sewage from such sewers it becomes necessary to handle great quantities of water that is not properly sewage, and consequently increase the average cost per sewer connection. In the case of Low Level Sewer No. 4, at Alliance, which is defective, as above mentioned.

The Sewage Disposal Plant is now handling and has been handling during the past year 150,000 gallons of water per day discharged by this sewer into East Side Main Sewer No. 2. This is purely drainage water, as there are no connections made with this sewer, nor is there a flush tank in operation at the head of the sewer. In other words, we have by the building of Sewer No. 4, at Alliance, Ohio, doubled the sewage that must be handled at the Disposal Works. A more forcible example of the results of defective sewer works can hardly be referred to anywhere.

This sewer cost the city for construction $4218.51. Not a dollar's worth of assessments have been collected. No one uses it as yet, and each year the city is compelled to dispose of the water collected by this sewer, as it will finally become contaminated by having sewage emptied through connections into it, and as it is now added to the sewage flowing from the city in Sewer No. 2. All other sanitary sewers in the city are very substantially built, and have given no trouble in any way. At the

beginning of the year there were 65 house connections to the sanitary sewer system, and at the end of the year there were 175 connections. (All connections are 4 inches internal diameters.) A daily average of these house connections as constructed and put into use will amount to 117, so that we have 117 connections running for one year.

Twelve automatic flush tanks empty into the sanitary sewers, each discharging about 1200 gallons daily. This large discharge from the flush tanks is thought to be advisable on account of the comparatively small number of connections, they not discharging enough water into the sewers to carry off the solid matters as rapidly as it should be removed.

During the year there have been 180 pounds of chemicals added to the sewage each day. There have been precipitated and pressed at the works 650 pounds of sludge daily, or there have been separated from the sewage 470 pounds of organic matter each day (not including the chemicals added), so that each of the 117 house connections has discharged into the sanitary sewers 4 pounds of organic matter daily. The weights were all found after the material had been thoroughly dried by heat from the boiler at the works. The sludge after being pressed is hauled away by farmers living near the city, and is disposed of on their lands. The city has not been to any expense in the disposal of it, as the farmers haul it for what it is worth.

During the past year the State Board of Health has made several analyses of the sewage and effluent at the works, the results of which are given in the following table.*

SEE TABLE ON NEXT PAGE

*Note.—For detailed discussion of these results as well as the river water at Alliance for the summer and fall of 1897 see "Preliminary Report of an Investigation of Rivers and Deep Ground Waters of Ohio as Sources of Public Water Supplies," by the Ohio State Board of Health, 1897-1898.

REPORT OF CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF SEWAGE AND EFFLUENT FROM SEWAGE DISPOSAL PLANT AT ALLIANCE.

	June 19		July 24		August 27		September 30		October 7		October 27*	
	Sewage	Effluent	Sewage	Effluent	Sewage	Effluent	Sewage	Effluent	Sewage	Effluent	Sewage	Effluent
Color	0.3	0.25	0.3	0.2	0.2	0.2	0.3	0.25	0.25	0.25	......	......
Turbidity	Slight	Slight	None	None	Slight	Very Slight	Distinct	Slight	Trace	Very Slight	......	......
Sediment	Very Marked	Slight	Marked	Marked	Marked	Marked	Marked	Slight	Marked	Slight	......	......
Odor	Offensive	Earthy	Offensive	Faint Musty	Oily and Slightly Offensive	Slightly Greasy & Musty	Slightly Offensive	Very Faint Musty	Oily	Musty	......	......
Oxygen Required	1.92	0.69	0.98	0.65	0.83	0.78	0.85	0.72	1.00	0.77	......	......
Ammonia free	1.0592	.3520	.1636	.1480	.0828	.1608	.3180	.2900	.2370	.2380	......	......
Ammonia- Albuminoid	.2640	.0748	.0864	.0600	.0708	.0748	.1970	.0870	.1380	.0950	......	......
Nitrates	None	None	.044	.036	.061	.053	None	None	.009	None	......	......
Nitrites	.0019	.0401	.0185	.0332	.0150	.0025	None	None	.0300	.0015	......	......
Chlorine	3.0	2.1	2.55	3.25	1.65	2.23	1.85	1.90	1.50	1.70	......	......
Hardness—Temporary	21.2	14.6	15.8	13.4	17.8	17.8	20.0	15.0	18.6	14.2	......	......
Hardness Permanent	17.4	12.0	12.8	14.0	9.4	11.0	9.4	8.4	10.0	10.2	......	......
Total Solids	49.0	39.5	47.5	49.0	49.0	48.0	52.5	44.0	49.0	42.0	......	......
Volatile & Combustible	11.0	6.5	8.0	9.0	8.5	9.5	10.0	6.5	10.0	8.5	......	......
Oxygen, mg. per litre	......	......	......	0.98	......	0.2	......	......	......	......	......	0.
Bacteria per c.	196260	71360	105600	459680	40400	561400	......	......	......	......	146200	1111500
Hour of Collection	9 a.	9:30 a.	12 m.	12:15 p.	3:30 p.	4:00 p.	12 m. Sept. 30 to 12 m. Oct. 1		12 m. Oct. 7 to 12 m. Oct. 8		......	
Flow of Sewage, (gals)	......		......		......		277540		304793		......	
Amt. of Lime (pounds)	......		......		......		300		320		......	
Amt of Alum (pounds)	......		......		......		None		40		......	

*No samples taken for chemical analysis. Samples for Sept. 30 and Oct. 7 were composite. No bacteriological examinations were made.

Less than 1000 feet above the outlet of the Disposal Works the Alliance Water Works Company have a dam constructed. During the summer season nearly all the water is diverted into the water works settling basins, in fact at two different times during the past year not a drop of water has poured over the water works dam for a period of 7 days. At these times the water had been lowered by blowing off the dam for repairs, and there was very little leakage through the dam. During all this time the effluent from the works was being allowed to flow into the river. Fish have been caught almost every day, and at the very outlet of the works. At no time has the effluent been injurious to life in and along the river. Neither plant nor animal life has seemed to multiply or diminish in quantity nor change in character. Considering all perceptible conditions, the river below the works is apparently normal to the condition of the same river above the works.

HOW THE PLANT DOES IT.

The sewage passing through the inlet channel receives the proper solutions of lime and alum and is thoroughly mixed with these chemicals by means of a series of deflecting boards in the inlet channel just before it enters the circulation channel. The gates being so arranged in the circulating channel, the sewage flows into and circulates through tank No. 1, and again into the circulating channel. This operation is repeated in tank No. 2 and tank No. 3, the effluent then pouring over the steps of the outlet channel and into the outlet sewer. During the passage of the sewage through these tanks the chemical action induced by the lime and alum added to the crude sewage causes the organic matter in the sewage to be deposited in the bottom of the tanks in a semi-fluid state. When it becomes necessary to clean one of these tanks, the gates are then so arranged that the sewage flows past the tank which is to be cleaned and circulates through the two remaining tanks. After the sewage has been allowed to stand for some time in the tank so cut off, the condition of absolute rest of this liquid results in the organic matter settling to the bottom, leaving the clarified sewage or effluent on the surface. The clarified sewage is then drained off by means of a skimmer pipe into the 12-inch clear water drain extending under the bottoms of the tanks. After the clarified sewage is drained down to the level of the sludge, the valves on the clear water drain are closed and the sludge drain valves opened, allowing the suidge to flow into the 15-inch sludge drain and empty into the sludge well. The sludge is from this well lifted by means of a sludge forcing pump in the engine room into the filter press, where the solid matter contained in the sludge is retained in the press and formed into disk-shaped cakes about 28 inches in diameter and 1½ inches thick. The water which is extracted from the sludge by the pressing operation falls into a depression in the concrete floor beneath the press and flows into the inlet channel, being again treated to the precipitation process. After the

press has been compactly filled, the sludge pump is stopped and the press allowed to drain. The press is then opened and the sludge cakes allowed to fall into a sludge car, which is run under the press for this purpose. The sludge car is then run over an iron track to the dumping ground east of the tanks, the sludge is there stored until it can be hauled away and used as fertilizer.

WHAT IT COSTS TO CONSTRUCT.

The cost of the plant is as follows:

Land, about 2 acres	2,150 00
Engineering, superintending, inspection, plans, etc	1,192 75
Tanks, wells and drains	7,506 04
Building and stack	5,143 75
Machinery and boiler	3,653 00
Gates, valves, iron pipes, etc	710 41
Plumbing and heating	44 32
Sludge, car track and bridge	35 69
Tools	24 82
Grading and improving grounds	207 65
Engineer's residence	87 19
Total	$20,755 62

The land on which the plant is built is located in a narrow gully through which flows a small stream. This gully extends north and south and opens out into the Mahoning river. There are about 2 acres of land in the tract, and it cost the city the sum before mentioned, which is a very good price for land in that locality. The land was very rough and grown up with brush, and in constructing the works it was necessary to excavate a new channel for the small stream nearly entirely across the land bought. This channel is ten feet wide at the bottom, slopes 1 to 1, averaging about 5 feet deep and is 400 feet long.

The following prices were paid for these works:

Excavation, 17 cents per cubic yard; soiling and back filling, 20 cents per cubic yard; brick masonry, 23 3-4 cents per cubic foot; bottom paving of tanks, $1.35 per square yard; 3-inch stone coping, 17 cents per square foot; 18-inch sewers and drains, $1.45 per lin. foot; 15 and 12-inch sewers and drains, $1.35 per lin. foot; sludge well, $400.00; clear water well, $250.00; manhole on inlet sewer, $60.00; manhole on clear water drain, $35.00.

Building and stack were let in one contract and cost as shown. The machinery cost as follows: Boiler complete, $700.00; filter press, $1300.00; vertical engine, $500.00; chemical mixers, $500.00; centrifugal pump, $250.00; sludge forcing pump, $450.00. Contracts for machinery included a six months' guarantee against all breakages.

WHAT IT COSTS TO OPERATE.

Operating expenses during the past year have been as follows:

Labor	$838 77
Coal	195 90
Chemicals	132 34
Oil, washer and packing	16 07
Filter cloths	66 26
Repairs	30 36
Miscellaneous	11 05
Total	$1290 75

In operating the works two men are employed, an engineer and a helper. These two men perform all labor necessary for the operation of the plant, and also for such work as is necessary to the keeping up of the grounds. The engineer at the works receives $40.00 per month and house rent, fuel and oil for lighting. The helper is paid by the city, and at the rate of $1.25. Coal is bought by the car load, and costs $1.37 per ton, delivered at the works. This coal is what is known as run of mine coal. Common gray lime constitutes the only chemical used at the sewage Disposal Plant at Alliance, Ohio. It is bought direct from the kiln and costs for a bushel of 70 pounds delivered at the works, 14 cents. Oil, waste and packing are of such brands as are used in any plant operating engines and pumps. Oil has been bought by the barrel. The plant is lighted by oil, as it also the engineer's residence. The filter cloths are made of Burlaps. Two yards of 30-inch goods will make a cloth for one chamber, which, including brass grommets and making, cost 46 1-2 cents apiece. Repairs have been somewhat more costly this year than they should have been on account of boiler repairs, made necessary by a hand hole in the rear end under the flues. This hand hole is subject to great heat and this heat being very irregular, causes the arch over the hand hole to expand and contract alternately, and often, so that there is a tendency to leak around this hand hole. This leaking water, combined with the soot and hot gases, had eaten away the boiler plate to such an extent that it became necessary to place a patch. This patch, together with a leaking flue, are the causes of so large an item in the repair column.

COMMENTS.

That better sanitary conditions are necessary is no longer a debatable question. Engineers and health officers have long since refrained from arguing what to them is a self-evident truth, and have instead applied their energies towards the solving of the difficult problem, of how to dispose of the household wastes that are now discharged into every stream and lake. It is not a long while since only the large American cities were provided with sewers for sanitary purposes. At the present time all our large cities and many towns and villages, even those of 2000 and 3000 inhabitants, are disposing of their household wastes by means of sewers. These sewers have in many instances been allowed to discharge their contents into small streams. Streams that were at

one time clear and pure and were a valuable heritage to the lands through which they flow, by the adding of raw sewage to these streams they have become turbid and filthy. Plant and animal life has ceased to exist or is now represented by the lowest forms.

The Ohio State Board of Health is engaged in very commendable work in attempting to free our streams and lakes of these dangerous wastes, and should be encouraged and supported by all. While for sanitary reasons it is necessary to deposit our waste matter in a place where it cannot become dangerous to our homes; and while for financial reasons we should accomplish this result as cheaply as possible, yet we should not forget our neighbor who is so unfortunate as to be situated in a position in which he becomes a sufferer from our injudicious disposal of such waste matter, and if we do so far forget him as to attempt such disposal, it would be well if our State Board of Health could peremptorily jog our memories. In many cases it is only justice that sewage disposal should be compulsory.

Great care should be taken in the construction of sanitary sewers and house connections to the same. They should have perfectly constructed joints so that no leakage from any source can find its way into the system, nor any seapage can occur from the sewer into the surrounding ground.

Every gallon of water that is unnecessarily admitted into the sanitary sewers will increase the cost of disposing of that sewage whenever the project is undertaken. And every bit of sewage that flows into the ground at such a depth as sewers are usually built, tends to pollute the underground water, and if springs or wells are used, may be the cause of epidemics.

In choosing the location for a sewage disposal works, not only first cost, but operating expenses should be considered. It may be possible in many cases to flow the entire sewage of a city into a plant by gravity by simply extending a trunk sewer a few thousand feet. Whereas, if the works are constructed at the present outlet of the sewer it becomes necessary to continually lift the sewage by pumps and at a never ending expense. A comparatively large tract of land may be found a valuable acquisition to a chemical precipitation plant, as there should be room to dispose of at least a portion of the sludge, providing you do not choose to burn it, or a combination of precipitation and filtration might be adopted in some cases.

It is certainly possible to improve on the machinery now in use in a chemical precipitation sewage disposal plant, and possibly some of the machinery may be eliminated altogether or replaced by machinery of different designs and less expense to operate. In other words, I believe it possible to improve on the entire design of a sewage disposal plant, and combining precipitation with filtration of the effluent water acquire better results and at a less cost than are realized by any sewage disposal plant now in operation in this country. And there is no reason why the cost and operating expenses cannot be both kept within a reasonable limit.

Now that the question of sewage disposal is before us, it becomes necessary that we, as advocates of better sanitary conditions, should furnish information that will assist in leading to the desired conditions. Honest investigation should be carried on and results noted and recorded in such a way that they would be accessible to all who are really and earnestly interested in this matter.

Because an engineer has planned or constructed some particular plant for the disposal of sewage is no reason why he should tie himself to that particular manner of disposal. But on the other hand, he should not fail to note carefully all results. And then we should, as honest men, consider these results regardless of our own particular pet theories on sewage disposal.

Each particular plant has its known quantities within itself and perceptible to all. But what we want is not only these known quantities, but the unknown quantity, which is results. We need a standard of purity to attain to. It is all very well to have analyses made and recorded. Long sheets full of them, gotten up nicely are a thing of beauty, but what can we tell about them if we do not know by what standard they are to be measured.

There are solids in sewage, and the quicker we admit the fact the better for us and for sewage disposal. Solids that when precipitated and compressed accumulate on our hands and make us wonder what we will do with them when our sewer connections have been added to until we have ten or twenty times as much sludge as we now have. Solids that have tendency to decompose and rearrange themselves, but nevertheless solids that fill up space, whether it is in the bottom of a precipitation tank, whether it is added to land and there allowed to decompose, or whether it is streamed from the sewage on the surface of a filter bed.

To explain this statement it is only necessary to say that at Alliance there were pressed during the year 268 pressfuls of sludge. each pressful consisting of fifty chambers, each chamber being twenty-eight inches in diameter and 1 1-2 inches thick. This would aggregate for the year about 8000 cubic feet of sludge, or a cubical block of sludge twenty feet to a side; or if spread evenly one inch thick over a surface, would cover 96,000 square feet, or over two acres. And yet the Alliance plant has disposed of but twenty per cent. of the solids contained in the sewage, as shown by the analysis reported by the Ohio State Board of Health.

I might add that 27.7 per cent. of the weight and 12 1-2 per cent. of the bulk of this sludge is lime that was added for precipitation purposes.

DISCUSSION.

Mr. Gerrish: I have just had a chance to look at this anaylsis, the result of a test made by the State Board of Health. It almost seems as though some of the results were reversed; for instance, albuminoid

ammonia runs from .0708 in the sewage to .0748 in the effluent, an increase. Total solids in one case runs from 47.5 in the sewage to 49.0 in the effluent, actual increase. But the most astonishing thing is in the case of the bacteria—I hardly know what to think of that. I will read you some of the comparisons, as follows: 105,600 in the sewage, 459,680 in the effluent, an increase of about fourfold in the bacteria. Another is 146,200 in the sewage, with 1,111,500 in the effluent. Now, if those are correct, I am very much surprised. Possibly Mr. Pfouts can make an explanation.

Mr. Pfouts: That is partly why I made the statement I did in the latter part of my paper, that we should be honest in our investigations, no matter what we find out. We should know what virtue there is in a plant, and besides that I am not pleased with an analysis which does not give us a standard alongside of it. Just as the gentleman said, the bacteria might be dangerous, and they might not.

While we get these reports from the State Board of Health, it is pretty hard to tell what we have after we have gotten the report. The Alliance plant has run continuously since July 1, 1896. The valve was opened on the first day of July, 1896, and it has been kept open ever since. Not a particle of sewage is allowed to flow past tne plant.

If we don't give reports that are true of our investigations, there is not much use in giving them. If Alliance finds out this is not a good thing, she might as well tell other cities so they will not do the same thing. I am not condemning the plant, because I know the river below the works is in first-class condition. There has been no complaint, and as I said in my paper, animal and plant life has remained normal. Bass is to be found in the stream at the mouth of the works. I have not noticed that any animal life has been affected by the discharge of the effluent into the river.

Mr. Gerrish: During the dry weather flow, do you see any fungus, feathery growth or any sediment in the bottom of the pools?

Mr. Pfouts: No, sir; I did not. I went to particular pains to examine that. In turning up the gravel on the shallows, if polluted or unpurified sewage is added to the stream, a black sediment which looks like soot is found, but there was none in this case.

Mr. Gilpatrick: You say the river is pure as far as your knowledge goes; what is the basis of your knowledge—chemical or bacteriological?

Mr. Pfouts: Simply observation—the perceptible condition.

Mr. Gilpatrick: Take the case of 146,200 bacteria in the raw sewage and 1,111,500 in the effluent. Is there any considerable probability that the increase of bacteria from 146,000 up to a million can possibly be non-injurious bacteria?

Mr. Gerrish: Certainly; can't have spontaneous multiplication or generation there; can't create typhoid bacilli there.

Mr. Brown: These analyses which Mr. Pfouts has given were made by gentlemen employed by the State Board of Health to do that

work, one a chemist and the other a bacteriologist, both men of reputation and standing, who thoroughly understand their work. The samples were gathered once a month and the bacteriological examinations were started right on the ground when the sample for analysis was taken. The samples taken for analysis consisted each of a gallon of water. This was placed in a clean bottle with a glass stopper, thoroughly sealed and shipped by express to the chemist at the Ohio State University.

During the past summer I made several gaugings of the flow of the river below the water works and sewage outlet, about a thousand feet below the sewage disposal works. I had to wade and work in the water and so had a good opportunity to see its condition, and the good condition was astonishing as far as looks and smell was concerned. I went to Alliance from Marion, Galion and Kenton, towns on the Scioto and Olentangy rivers and somewhat larger than Alliance, and the river water at these places was most abominable—green, stinking, dirty water of the worst kind; in fact, strong sewage. But at Alliance the water was clear, no growth on stones, none of the green fungus which Mr. Gerrish spoke of under the pebbles, and around the edges of them there was no black muck—no odor at all; and several times while there I saw boys fishing in a little pool about a hundred feet above where we were working, catching fish which they pronounced bass. At Marion, Galion, Kenton, Columbus and on the lower Mahoning, the fish were killed by the thousands by sewage pollution. So this chemical precipitation surely does help the condition of the stream. That result of finding a larger number of bacteria in the effluent than in the raw sewage was a surprise to the bacteriologist as well as yourselves. He duplicated his work, but it came out the same several times. He explained it by saying that the lime did not kill the bacteria, and the sewage being disposed in tanks and kept warm, there were favorable conditions for rapid growth, and they grow with exceeding rapidity. Consequently it was simply a hotbed for the propagation of bacteria. Some of these bacteria may be disease germs, but a great many, the vast majority, fortunately, are not dangerous.

Mr. Gilpatrick: I would like to ask if those bacteria were examined from the standpoint of classification?

Mr. Brown: No, sir; the separation or classification is very difficult and would take a great deal of time, more than was available at this time.

Mr. Gilpatrick: I hope Mr. Pfouts this year will make an examination of the effluent from the plant and not after it has been diluted from contact with the stream.

Mr. Brown: The samples for these figures were taken where the water came out of the last settling basin, down the steps, just before it entered the river, and so was not diluted by the river water.

SEWER CONSTRUCTION AT MARION, O.

BY E. S. AULT, C. E.

Marion, Ohio, has a population of 12,000 people and every one of them are justly proud of all of our public improvements, especially our sanitary sewer system, which we who take any interest in that line of work consider one of the finest separate systems of sanitary sewers in the state of Ohio, and one which has always and will always give the people a good service, for it is properly constructed, with the exception of a part of the third district, which was very poorly constructed owing to poor inspection and the wrong theory of plans, which I will speak of later on.

Marion is divided into four sanitary sewer districts and two storm water districts, with all of the sanitary districts constructed and in running order, except the fourth district, which is under my charge of construction now.

We have ten miles of sanitary sewer constructed, including main and lateral sewers, ranging from 15-inch to 8-inch pipe, with an outlet three and three-tenths miles long of 18-inch pipe, and thirty-six flush tanks of the Rhoads-Williams and Miller pattern and making on the average of about three flush tanks to one mile of sewer. The size of the siphons used are 6 and 8-inch; the 6-inch siphon has a tank diameter of 4 1-2 feet with a discharging depth of thirty-four inches and with a discharging capacity of forty-two cubic feet or 315 gallons per dump, equal to 7 1-2 gallons per second, while the 8-inch siphon has a tank diameter of five feet with a discharging depth of thirty-nine inches and a discharging capacity of sixty-five cubic feet or 487.5 gallons per dump, equal to 16 1-2 gallons per second. Of the two siphon patterns I have just named, I would recommend the Miller in preference to any other I have used or have seen used, on account of its simplicity of construction. The flush tanks are equipped with the Thompson bee meter and the city is allowed 2 1-2 million gallons of water per year free of cost from the water works company for flushing purposes. The sewers are thoroughly cleaned in the fall of every year by good flushing from the flush tanks, and by floating balls and dragging heavy log chains through the pipe, removing all slime and fungus growth that may have accumulated within the year.

The outfall is 18 inches in diameter, is 17,302 feet long and has a capacity of 3,000,000 gallons daily, sufficient to serve a population of 37,500 people on a basis of 80 gallons per capita per day, while the main line of the First district, which is 15 inches in diameter, is 3710 feet long and has a capacity of 2,100,000 gallons daily and is sufficient for 26,196 people. The second district empties into this 15-inch pipe and the Third

district empties into the second, while the Fourth, like the First, empties directly into the outfall and from the capacity of the outfall and the main line of the First district you see that our system is amply large enough, as we have only 12,000 inhabitants and the outlet is equivalent to 37,500 or with a capacity of a little over three times our present population.

In the construction of the first two districts and a part of the Third district, provision was made for cellar drainage pipe to be laid in the same trench with the sanitary pipe. The cellar drain in the First and Second districts was laid above and a little to one side of the sanitary pipe after the latter had been held in place by rammed earth to a height of three inches above the pipe and then the cellar drain pipe (all straight, no specials) was laid a little to one side and was covered with one cubic foot of course screened stone to one lineal foot of pipe, after the placing of the crushed stone a foot of earth was then rammed above and around this and the rest of the trench was filled in with slushes, it was then flushed with water until the loose earth in the trench was completely saturated, the water disappearing to the cellar drain pipe and taking with it all fine material it could to the crushed stone, which made it practically useless for what it was intended. The object in placing the crushed stone around the cellar drain pipe was according to the rules regulating the use of the same, which was that the house cellar drains were to be butted up against the crushed stone, which was supposed at the time to be ample to drain all cellars dry, instead of being connected with the main pipe directly. The cellar drain experiment with the crushed stone proved an utter failure and the rules were changed so as to make direct connections with the main pipe after about two-thirds of all cellars had been connected. Although this cellar drain experiment proved a failure, it did not impair the sanitary sewer which had been laid directly under it, which was in perfect line and construction with the exception of now and then a corner would be found broken off at the body of the pipe by the settling of the cellar drain pipe.

The engineer in charge of the Third district thought he could overcome the evil by placing the sanitary pipe above the cellar drain pipe, but the engineer's wrong theory, together with an inexperienced inspector, produced a most disagreeable failure in every respect. The theory was wrong and is considered so by the most eminent sanitary engineers in the country, owing to the fact that it is almost impossible to lay an air-tight sanitary line of pipe and it does not matter how particular and careful the pipes are laid, there will be some seepage from them (25 per cent. as a rule is allowed for wild water). In this case, as in similar ones, the sewage matter seeped through at the joints of the sanitary pipe and entered the cellar drain pipe and there remained decomposed, and the gas went with a rush to the cellars of the houses that had been connected up and, having nothing to obstruct its passage (tapes being considered unnecessary. as the engineer thought at the time that no sewer gas would ever get into the cellar pipe from the sanitary sewer), polluted the cellars with the most dreadful gas imaginable.

The consequence is, technically speaking, the sanitary and cellar drain pipe changed places as far as sewer gas is concerned, while the pipe that was laid for sanitary purposes is now nothing but a long vent pipe (and a poor one at that). The cellar drain pipe being only a 6-inch pipe, has not the capacity of sanitary purposes and not being connected with the flush tanks, is also worthless, which makes a complete failure of the whole system in that district, but at the same time it cost the property owners along the line of construction $7500 for the experiment of a wrong theory. On complaint of residents along one line of this sewer to the City Council that their cellars were full of sewer gas which came from the main cellar pipe in the street, the City Council directed the City Civil Engineer to remedy this if possible. Both lines of pipe were taken up and relaid according to the former grade, as the manholes and flush tanks and grades could not be changed under the existing circumstances. There was three inches of concrete of the usual proportion placed on the top of the cellar drain pipe and being thoroughly drained, the sanitary pipe was laid upon this and has proven satisfactory at a cost of $600 to the taxpayers in general. Other lines of this district will have to be taken up or abandoned in the spring in general, as it is liable to be declared a detriment to public health in general, which will mean an outlay of $7000, which the people in general will have to pay.

In the construction of sanitary sewers within the last year all lamp holes and hand hole pipes have been disregarded and manholes have been built in their places and at a distance of about 500 feet apart. Hand hole pipes become useless after the streets have been paved and the expenditure of money in constructing lamp holes is greater than the benefit derived from their use. Lateral curves of 20 foot radius have been abandoned also and all laterals are run straight into the trunk line manholes. Although an increase of inclination is given all pipe around the curve to overcome the increased friction due to angular change in direction and also for the reason that as ordinarily laid there is a slight opening of the joints in the outward circumference and greater liability to stoppage from articles lodging crosswise and not being able to get at obstructions readily which may happen to get lodged around the curve, we have abandoned them entirely.

CITY FRANCHISES AND CITY STREETS—IN SMALL CITIES.

M. A. MUNN, MANSFIELD.

As the subject of the paper indicates, city franchises will be treated in their relation to the city's streets and more particularly in their relation to paved streets. It is not expected that anything new or startling will be presented. Rather it is the writer's wish to compare some interesting sections in several street railway franchises that have come into his possession; and perhaps to discuss the merits and demerits existing therein. The treatment will be limited to the conditions as found in small cities—cities having a population of from 15,000 to 30,000 inhabitants—since it is believed that it is in cities of this grade and class that the subject of franchises ought to be more thoroughly understood. Certainly it has been our experience that it is here that the owner of a corporation franchise most often tears up a well paved street, puts down an illy-constructed track or erects an unsightly pole in the unsightliest place without any one to molest or make afraid. For the purpose of obtaining exact knowledge of the extent to which the cities of this, our great commonwealth, are in the habit of protecting their streets against harm or injury, letters were addressed to the proper officials of those cities where a system of street railroads was known to be in operation, asking for a copy of the company's franchise. For the sake of comparison and illustration four franchises have been used, taken from the replies that have thus far been received. The first is from a city whose population in 1890 was about 30,000.

On Oct. 14, 1889, a franchise was granted for a term of 25 years. The following sections are quoted therefrom:

1. "The said company shall be required to pay the city of ———— an annual license of ten (10) dollars for each car running upon said railroads.

2. The said street railroad company shall upon the paved portion of ———— street, as soon as its tracks are laid, pave the space between the rails and a strip one foot wide along the outer side thereof, and the space between its tracks known as the "Devil Strip," with the same kind and quality of pavement as is used upon the balance of said street, except that where the same is now paved with asphalt the space hereinbefore specified shall be paved as aforesaid with suitable paving blocks, stones or other material, and shall upon the other improved streets specified herein, and the improved portion of ———— street, as soon as its tracks are laid therein, pave the space between the rails and also the "Devil Strip" with suitable paving stone or brick. All of the work and material mentioned in this section to be approved by a committee of council and City Civil Engineer."

The second franchise comes from a city whose population in 1890 was 25,000. The franchise is for 25 years and was granted on March 31, 1884. The following section, while not bearing directly upon the subject, is nevertheless interesting. "Said company shall place upon the road, cars of good construction, with the latest improvements for the convenience and comfort of passengers. The cars thereon to be drawn by horses or mules." It is safe to say that in this city the mules have been relegated to the pasture field; but on the other hand the question lodges in one's mind for an instant whether the mules' hoofs or the thump of the motor car is more destructive to a paved street. The following section of this franchise relates to the company's care of the streets:

"That all tracks laid and constructed by ——— Street Railway Company * * * * in any or all of said streets. * * * * shall be laid as near the center of the street as practicable. * * * * The top surface of the rails to be so laid, and such rail used, * * as to be no impediment to the ordinary use of such street or streets or part of streets, by wagons and carriages. The space between such rails and for a distance of eighteen inches outside shall be filled with a bed of pounded stone or other good and suitable materials to the depth of at least six inches in thickness; and the top surface thereof to be covered over with a coat of clean gravel; * * * * that upon any or all paved or macadamized streets used, the paving or other material displaced in constructing such road shall again be properly replaced by such grantees to such grade, style and manner as it previously existed, or as council may then or thereafter provide for by ordinance. And such filling, paving or macadamizing between the rail and eighteen inches beyond on either side of track shall be maintained by said company and kept in good repair during such term hereby granted by said grantees." The letter accompanying this franchise states that "in the later ordinances the railway company has to pay for the paving between the rails and for a distance of eighteen inches on either side thereof."

The third franchise is from a city whose population, according to the census of 1890, was 27,000. The franchise is for a term of 25 years. On May 28, 1888, a section amendatory to the original franchise was passed by the City Council which contains the requirements that any company granted a similar franchise upon any street or highway shall pave or repair, macadamize or remacadamize such street or highway between the rails of the tracks and one foot on the outside thereof; and that such paving or macadamizing shall be with the same kind and quality of material as is used for the adjoining portion of the street.

The fourth franchise received was of particular interest because it came from a smaller city, one whose population in 1890 was about 16,000. The term of years of the grant is not stated. There are several items of interest contained therein as follows:

1. "The rails to be used on said extension (the franchise is an extension of the original) shall weigh not less than fifty-six (56) pounds per lineal yard.

2. Whenever the city of ——— may declare it necessary by an "improvement resolution" to pave or macadamize any or all of the streets over which the franchise is granted, the company shall pay the cost of said improvement between the rails of its tracks and for eighteen inches outside.

3. That said company shall secure a permit before tearing up any portion of any street.

4. That in case of a change of grade, said company shall pay the cost of changing grade of track.

On Feb. 10, 1887, a 25-year franchise was granted to S. T. Dunham or assigns for the purpose of operating a street railroad in Mansfield, O. The requirements for the repair of streets occupied by the tracks of this company are as follows: That the tracks shall not be laid above the surface of the street and must be laid in such manner that carriages can easily cross at all points in all directions without obstruction. That the company shall keep the space between the rails or their track in good repair satisfactory to City Council, but no provision is made for paving of said track.

Reviewing the text of the sections quoted from the several franchises referred to herein, we find:

That all are for terms of twenty-five years.

That all require the track to be kept in repair and that these repairs shall be acceptable to either council or city engineer.

That one demands a license for the operation of cars.

That one specifies the weight of rail to be used.

That four, or all but Mansfield, require the cost of paving between rails and tracks to be paid by the company.

That one specifies the kind of material to be used for paving upon asphalt streets.

That one requires a permit before the street may be opened for repairs, and

That one makes particular reference to change of grade. Notwithstanding these precautions, the writer believes that it is universally true, even in more pretentious cities than these referred to, that when a street pavement fails, it fails first of all adjacent to the street railway tracks; and that in the large majority of cases it is sure to fail with such track construction as may be allowed by the above requirements. As an illustration, on March 17, 1896, the Barber Asphalt Paving Co. entered into a contract with our City Council to lay sheet asphalt upon a thoroughfare occupied by a street railway track. The work was done upon a broken stone foundation, as also was laid the track of the street railway company. (Here allow me to say, in parenthesis, that the question as to who must pay the cost of paving the street car track was argued by the city and the company from the Common Pleas Court of the County to the Supreme Court of the State. The city finally footed the bill, for the court held that "repair" did not mean "to pave," and the franchise read "repair.") The asphalt pavement has thus far stood without a break, except for a space varying from a few inches to a foot

in width along the rails of the track. The first signs of failure began to appear soon after the pavement was completed and was undoubtedly due to insufficient weight and depth of rail and a poor foundation. Fortunately for the city the asphalt company was required to keep the street in repair for a period of five years from date of completion. They have just completed their first job of repair, having spent their holiday vacation upon this street. Again: Our main street was torn up about two years since for the purpose of replacing a side-bearing for a 60-pound, 5-inch girder rail. The new rail was set directly upon the cross-ties and the ties were imbedded in a foundation of broken stone. The pavers when relaid took up four of the five inches between the surface of the street and the top of ties, leaving one inch of sand for the pavers to rest upon. It is needless to say that this part of the street soon had more the appearance of a corduroy road than a paved thoroughfare. However, the "repair" clause of the franchise was this time effective and the company was finally prevailed upon to remedy this defect, so that as far as the street railway track is concerned Main street can once more lift up her head. We have, however, taken one step in the right direction. On Dec. 21, 1897, a franchise supplemental to the original was granted for a term of 25 years in consideration of a road being built to Shelby, O. The section referring to the repair of streets was amended to include the space between the rails and eighteen inches outside on both sides, the work to be done under the supervision of the City Civil Engineer. "And whenever said company shall remove any part of its roadbed, ties or rails for improvement or replacement, the said ties shall be replaced upon a bed of concrete, or such foundation as shall keep said ties from loosening or displacing any brick or asphalt improvement laid by said city within or about said tracks, the same to be conducted under the supervision of the City Civil Engineer." This in some respects was a feeble step. In the light of the experience gained on the asphalt street above mentioned, it would naturally be supposed that a clause would have been inserted relative to paving the company's tracks.

Finally, gentlemen, allow a young man to make a few suggestions:

1. That the 25-year franchise and the "good thing" franchise have or ought to have seen their day. A maximum term of ten years is, we think, a sufficient period of time to grant a company exclusive use to a portion of a city's thoroughfare. And if anything is a "good thing" it ought to be good enough to pay for the privileges granted, even in cities of the size referred to in this paper. Charge the company a fixed sum per annum for every car operated over its lines and make this license a street repair fund.

2. Avoid generalities and stick closely to specific statements as regards kind of work to be done and material to be used in making repairs and in laying new pavement. Write in large letters, that the company shall pave its tracks at its own expense; that upon streets

paved with brick or asphalt the track shall be laid upon a bed of concrete; that a rail of specified weight and depth shall be used.

3. Make all work be to the acceptance of the City Civil Engineer and require that a permit shall be obtained from his office before any work shall be undertaken.

REPORT OF COMMITTEE ON RAILWAY ENGINEERING.

W. B. HANLON, CHAIRMAN, CLEVELAND.

Your Committee on Railway Engineering, upon glancing over the field, are impressed with the fact bearing upon this branch of engineering, that during the year just closed a large expenditure of capital has been made by owners of railway property and franchises, and next to the least number of miles of new line built in any one year since 1889. Reliable reports published for the year give the mileage as 1938 miles, with California credited with the largest, 169 miles, Pennsylvania 140, Louisiana 130, Illinois 106 and with remainder distributed over thirty-three states and territories, Ohio having the estimated mileage of five miles.

Following up the main branches of work upon which capital has been expended, we find as follows: Track elevation, change of alignment and reduction of grades, improvements of terminals and signaling.

The very extensive plan for elevation of tracks in Chicago has been brought about by the railway companies and is being done under special ordinances prepared by the railway company engineers, and acting in conjunction with engineers of the city.

The ordinances passed, from the first one in 1892 to date, provide for the elevation of forty-two miles of main track, eliminating 229 grade crossings at an estimated cost of $16,400,000. Ordinances for seventeen miles of this work, eliminating eighty-eight crossing at an estimated cost of $8,350,000, having been passed during 1897.

The Erie Railway has provided plans and specifications for such work as provided for in ordinances passed at Jersey City, the same estimated to cost $1,200,000. Very extensive work has also been in progress on the N. Y. C. & H. R.

In the work of changing alignment and reduction of grades, the B. & O. have spent $100,000 on one mile of line in the Allegheny mountains. Extensive work has also been completed on the Pittsburg, Bessemer & Lake Erie R. R., between Butler, Pa., and Conneaut, Ohio.

In the work of union stations and terminals, this city is now credited with having one of the most beautiful and well arranged stations in the country, the estimated cost of which is given at $600,000.

For the city of Boston plans have been prepared for terminals estimated to cost $10,000,000, $7,000,000 of which is for real estate alone and an additional million to be expended by the city for streets and docks to accommodate the proposed improvement.

The B. & O. have recently completed freight terminals at Pittsburg costing $490,000.

During the year two of the largest interlocking plants in the United States have been put into use near Chicago: At Hammond, Ind., built by the Union Switch Signal Co., having space for 224 levers, with 136 now in operation. At Dalton, Ill., built by the National Switch and Signal Co., with 172 levers.

This brief glance over the year's work indicates that the work of the railway engineer is tending more toward the betterment of existing properties than to building new lines, and that there is a vast field in that direction to be further developed by the profession, we all will agree.

MAINTENANCE OF WAY ON RAILWAYS.

JOHN W. ATKINSON, GALION.

Mr. Chairman and Gentlemen of the Convention:

As Pennington has failed thus far to perfect his "aerial ship" as a safe means of transportation, we will still continue to carry on all commercial intercourse in our inland portions by rail, on this terrestrial ball.

Many roads that run the finest palace cars and circulate flaming advertisements throughout our country, oftentimes run over a very poor track at a rate of speed from fifty to sixty miles per hour, and the press is oftentimes right, after an accident, in proclaiming such roads traps, licensed to slaughter in a wholesale manner. Others keep up a fairly good track at an expense twenty-five per cent. too great for the best. Where the Maintenance of Way Department is well operated throughout with some system and economy, the general manager has performed the greater part of his duty to his employers and the public in general. If this department is good all others are sure to be, but do we really find it the case? The answer is: "Very rarely." The expense of operating our American railroads is from twenty to twenty-five per cent of total expenses. There are no easier ways of wasting money than in this department.

Have the different departments been developed uniformly? The answer is: They have not. This department on many roads is most noticeably behind, which can be conducted at least expense when the track is in good repair, but on the contrary, as little money as possible is expended in keeping the track in good repair, while other departments are brought to a high degree of perfection. It is possi-

ble to reduce the list of railroad accidents caused by defective railroad tracks to a minimum, and at a very slight extra cost. The majority of accidents caused by defective track is small in comparison with those caused by faults of the telegraph and transportation departments, which will always be large on account of the large number of cheap and incompetent laborers they too frequently place in responsible positions.

The question is asked: Who is the proper party to have charge of the Maintenance of Way Department? The general superintendent or general manager, under him there are various methods. The roadmaster is usually next in rank, and on most all roads the roadmaster and engineer of maintenance of way are of equal rank and are one and the same office. All things being equal, it is best to conduct a business under one competent and responsible head instead of having the responsibility so placed that it can be shifted on others. There should be no exceptions to this department, and the engineer should have full authority upon questions pertaining to the Maintenance of Way Department, including tracks, masonry work, bridges, structures, surveys, new work and right of way. This requires the immediate supervision of an engineer capable of noticing the most minute details as well as the ability and experience to make plans for the improvements so complete that a little work done here in one place and a little somewhere else will in the future, after many years of toil and perseverance, form one complete whole. In this case, it is usually hard to carry out a plan of this kind, for those in authority cannot see the advantage of a little extra expenditure.

In reality, the first work toward making maintenance of way cost less should be done when the road is located and built. It should be done so well at first that there would be no faults of original construction to remedy and the cost of maintenance would be greatly reduced.

To do this, the company should have money enough to lay aside all minor considerations and construct in such a manner that it may prove economical for years to come instead of for the first few years.

It is not possible in the space of this short paper to speak separately of the many things pertaining to the maintenance of way of track, but a few points of interest to engineers will be noticed.

As we now operate railroads, we must prepare for great speed, from fifty to sixty miles per hour in passenger service, consisting of heavy trains made up of heavy engines and cars, and in freight service for trains of from forty to fifty loaded cars. To make track safe to operate under these conditions, we should have transition or spiral curves to curve and tangent, and vertical curves to connect different grades. There are various methods for the use of these easement curves, a few of the most noted for practical use being A. M. Wellington, S. W. Robinson, William H. Searles and others. From the above authors we may have an occasion to quote.

The spiral curve is regarded by some as difficult, theoretical and hard to reduce to practical work in the field, but such is not the case. It is highly practicable and can be laid out on the ground almost as easily as a circular curve without disturbing the lateral equilibrium, causing the disagreeable shock to the car so frequently felt. You will find these easement curves in first-class track, whether laid out by the engineer or not. The circular curve may be properly staked out, but to the practical eye it does not look right. The section man will not follow the stakes at the tangent points, but will go back on the tangent and begin his curve, throwing the track until it suits his eye. This may produce an easy riding curve, but at best it is only a bungling way of adjusting a fault.

In retracing an old curve you will usually find it thrown in at the tangent points, or the tangent thrown out a little. On a curve in this condition you may introduce a circular curve of a larger radius than that of the main curve. This form is advocated by so high an authority as the Pennsylvania railroad, but does not appear to be very extensively used. It is certainl better than nothing, and may in many cases be sufficient. In using this form, we may either leave the original P. C. unchanged and shorten the radius of the central curve, or the starting point of the easement curve (which we will call the P. T. C.) may be moved back along the tangent to some point, A, and the radius of the central curve remain unchanged.

See formulas given by Henck, Sec. 81.

A compound curve made up of several arcs, having chords of equal lengths and of regularly increasing degrees of curvature—easement curves of this form are usually called "taper curves" and are in much more general use than in the preceding form. Engineers who have used them differ greatly in the methods which they employ in setting them out, and in the values which they give to the length and deflection of angles of the equal chords.

William Hood, C. E., uses chords thirty feet long (or one rail length) and employs three different tapers, according to the degree of curvature of the central curve. The first changes no degrees and thirty minutes to each thirty feet, the second one degree to each thirty feet and the third two degrees, thirty minutes to each thirty feet.

The curve is laid out by deflection angles, with a transit. Formulas and tables may be found for this method in Engineering News, Vol. 20, pages 42 and 60.

A. L. Mills, C. E., uses successive arcs of one degree, two degrees and three degrees, etc., curves, but varies the length of the equal chords, according to the degree of curvature of the central curve, from 100 feet for a three degree, 30 minute curve, or less, to thirty feet for a six degree, thirty-one minute curve, or more. The curve is set out by offsets from tangent. His formulas and tables may be found in Engineering News, Vol. 20, page 133.

Curves of this form do not seem to meet precisely the theoretical requirements of the case, but when the chords used are not too lo—

and the changes of curvature not too abrupt, the approximation is sufficiently close for all practical purposes.

They are all subject to serious objection in that they require the use of somewhat complicated formulas and either elaborate tables of offsets or deflections or frequent movement of the transit, at considerable loss of time.

The ideal form of easement curve is what is commonly called a "spiral," and is a curve whose radius, commencing with infinity at the junction of the curve with the tangent (P. T. C.) gradually diminishing, until at the junction with the central curve (P. C. C.) it is equal to the radius of that curve. A curve of this form meets exactly the theoretical requirements of a transition curve.

When a train is passing around a curve, the centrifugal force causes a constant tendency to mount the rail and leave the track on the outside. This tendency is overcome in practice by elevating the outer rail sufficiently to cunteract the centrifugal force by creating an equal tendency to slide inward under the action of gravity. The centrifugal force, and consequently the elevation of the rail, is proportionate to the degree of curvature, and where a track is formed as usual, of a tangent and single circular curve, theory requires that at the joint of curvature the outer rail should have the full elevation due to the curve, and at the same time no elevation at all for the tangent. This, of course, is impossible, and in practice the elevation is run out along the tangent at a rate from fifty to sixty feet for each inch of elevation.

This practice introduces elevation where it is not needed, and is an evil only less than the one it is intended to remedy, and therefore ought, if possible, be avoided. This is done in the most perfect manner by introducing a transition curve in which the elevation, beginning at "0" at one end of the curve, increases uniformly until at the other end it is equal to the full amount due to the central curve. The maximum elevation should not be greater than six inches, except in special cases. And the theory given by formula, it is believed so to be, when the radius of curvature varies inversely, as the square of the distance from the point of tangency. The object in using the square is to reduce any difficulty due to entering upon the curve to the least possible value. By choosing the law of the square, the increased motion of the car in its rotation upon its longitudinal axis is made constant.

In using this form of curve in locating a new road, Wellington's or Robinson's tables are perhaps the best, for the reason that there is liable to be too much change on old roadbed. Searle's tables are perhaps the best to use on old track. There is less liability to change in an old roadbed, and therefore less expense in changing curve. In fitting spiral curves to old track it is well to first notice the rail joints and see if they are not too tight, too loose or just right, and the selection of the spiral curve will be governed accordingly.

If the degree of curvature of the circular center curve is left the same or only slightly increased, the curve will be thrown in and short-

ened, and consequently the joints tightened. If the central curvature is increased the curve will be lengthened by being thrown out more, and the joints loosened.

In the operation of a railroad it is the grades, not the curves, that occupy the most important place. It is impossible, or we might say, not desirable, to have a perfectly uniform grade from one end of the road to the other.

The profit of a road usually depends on its ability to haul freight cheaply, and its freedom from accidents. For example, we propose to build a road 200 miles long. The preliminary work done, and we have determined on a maximum grade, which for convenience we will say is a one per cent. grade, and whenever and wherever, it can be used to advantage, in construction, it is used.

All grades should be connected by good, vertical curves; the expense of construction will be but little more, while the economy and safety of operation will be greatly increased. The trouble, danger and expense of operation is increased by sags in the grade line, that are so frequently difficult and expensive to take out. Unless the sags in grade line are deep enough to affect the ruling grade, its disadvantage is in the extra wear and tear of rolling stock, and danger of breaking trains.

Wellington shows in his table that curves should be 400 feet long, or 200 feet on each side of vertex, for each tenth in change of rate of grade, per station. Not over 0.025 per station, if all possibility of bringing the drawbars of any part of the train into compression, while passing over it, is to be avoided. With half this length of curve, all danger of taking out the slack in the front half of the train, where there is the most danger of breaking the train, will be avoided

In the operation of railroads, special attention should be given to "expansion joints." "Iron shims," to separate the rails at the joints, must always be used in laying track. The proper thickness for coldest weather is five-sixteenths of an inch; during spring and fall, use one-eighth of an inch, and in the very hottest weather, one-sixteenth of an inch shouold be allowed; the rails supposed to be of a uniform length. This rule must be carefully observed, as many serious accidents have occurred by neglecting this simple method of making proper allowance for expansion. Any rail or fastening is weak compared with the powerful expansive forces of the sun's rays.

In operating a railroad it is of great importance to pay particular notice to the gauge of track. We will speak of the standard form—four feet, eight and one-half inches.

There must be four feet, eight and one-half inches on straight track and on curves less than two degrees. On curves of two degrees and over, it must be widened as follows:

For two degrees it must be increased one-eighth of an inch.
For four degrees it must be increased one-fourth of an inch.
For six degrees it must be increased three-eighths of an inch.
For eight degrees it must be increased one-half of an inch.

One very important point to notice in the operation of a railroad is the location and size of frogs. A number ten frog, with an eighty-two and one-half feet lead for main track, is perhaps the best to use, and frogs of less number and shorter leads are used on sidings, spurs, etc.

In speaking of a few items on maintenance of way on railways, we think it proper to notice tie plates. On many roads they are used, while on others they are discarded, but we think that they can be used to an advantage on curves and switches. The ribbed plate is a good form and largely takes the place of rail braces. What is most noticeable in maintaining good track is the quality and quantity of ballast that is used to give perfect drainage, to prevent upheaval by frost, to distribute the bearing of the ties and to secure as uniform support for the track as possible.

Foremen, when preparing the subgrade for ballasting track, must be guided by the standard diagrams and stakes for line and surface, set by an engineer, when practicable.

In connection with ballast, we will notice cattle guards and road crossings, which are, as a usual thing, a source of great nuisance to the traveling public, and oftimes really neglected, and more especially so, the latter, in our cities and towns. It is therefore, necessary, that we take more pride and be more particular in all small details of every-day work, and in the end a railroad will be better equipped in every detail by having the engineering work done well and competent engineers to have charge of maintenance of way.

SOME ACTUAL BRIDGES—PAST AND PRESENT.

BY H. L. WEBER AND FRED R. CHARLES.

Looking backward along the vista of years, stretching far past the middle of the century toward its first quarter, a vision meets our eyes, strange and motley, yet full of life and interest.

Beginning in Maryland and winding its sinuous course over the mountains of Pennsylvania, the hills and valleys of Ohio, through the forest and farm lands of Indiana until lost amid the prairies of Illinois, was a highway, bearing to the country the same relation as a main artery to the human body, pulsing with life and motion. The "National" or "Cumberland" road was the main avenue from the east to the west. No other road in the country did the same amount of business. There was a continuous flow of life and travel. In our vision we see wagons so numerous that the horses of one had their noses in the trough of the next; coaches dashed along, carrying travelers on business or pleasure bent; private carriages filled with the brave and the fair; horsemen with stuffed saddlebags; enormous droves of cattle and sheep, raising clouds of dust. Occasionally Mr. Clay or General Jackson made appearance and answered with stately courtesy the greetings showered upon him. And lest the road should grow too tame and the journey lack zest and interest, the way was spiced by occasional assaults of highwaymen, who found ambush and shelter in the dense thickets and shady dells along the road.

This generation can scarcely realize the importance which the National road attained in its palmy days. Constructed by the general government, it was one of the most important works ever executed by humanity. From the moment of its inception it was so recognized. On the question of its construction and the details of its maintenance political parties rose and fell; statesmen spoke and labored.

The perpetuity of the Union of States was declared to be at stake; the utter failure of self-government by men would result; free institutions would be lost forever "if the general government should erect a toll gate on the Cumberland road in any of the states in which the road lies." Henry Beeson, a congressman at the time, once made a speech in which he proved—so flexible is arithmetic, combined with a fertile imagination—that from the number of horse shoes required and the number of nails, "the National road was better adapted to promote trade than any railway could possibly be." It was also shown and seriously maintained that, if this avenue to the west should be provided, the tide of emigration would set so strongly from the east

as to entirely depopulate that section of the country. So early Ohio and Indiana were recognized as the land of promise, toward which the people would flock were a feasible road offered. But in spite of opposing interests the road was made, and in general made in a manner worthy of governmental work. It has been called a "triumph of the Stone Age." Gangs of men were engaged in quarrying and breaking stone to be used in its foundation and surface. The bridges were mostly well planned and well built for that early day. As was stated by a noted statesman of the period, "The Cumberland road would of itself constitute a more durable monument of the nation's glory than has been left by any of the free governments which have preceded our republic." But the old road belongs to a bygone civilization. The Pullman car has superseded the stage coach. Closely parallel to the old road runs the railway, and the hoarse whistle of the locomotive seems to mock the faded glory of its lowly neighbor. All things are subject to change and decay. The old road is now little but a memory. Its course is only marked, oftimes, by a line of decaying structures; bridges whose day of usefulness is past and taverns whose glory has departed forever. In portions of its length the dust is scarcely stirred from year to year; but again its course lies through the busy haunts of men. Many of the villages have fallen asleep, but on the other hand places once lonely and devoted to the call of the quail and the wild turkey now are filled with the ebb and flow of human life.

It is meet that engineers of the present generation should recognize the fact that in the achievements of bygone days there is something worthy of contemplation; that while our age is one of eminent engineering and mechanical victories, our predecessors planned and carried out works as great and suitable for their times as any at the present. We should not hesitate to pay tribute to the engineering knowledge and skill that planned these structures; to the honest, careful workmanship that was placed on them, and to the stability and symmetry of the finished product. Most of the bridges on the National road have served their time, and served it well. They are being abandoned and superseded by structures more pretentious and up-to-date. They will soon pass from the memory of man and be lost forever. For this reason it is especially proper for us to examine some old-time structures which are worthy of notice, and their projectors to more than ordinary credit. Two bridges of this character are the one over White river at Indianapolis and the one over Whitewater at Richmond, Indiana; the former a monument to Engineer William Wernwag; the latter to William Dewey. These were erected in the years 1832-34; Congress in 1832 having appropriated $100,000 for work on the Cumberland road in Indiana. Indianapolis was the headquarters of construction and work was prosecuted in both directions from there. General John Milroy was superintendent of construction from Indianapolis to the Ohio line, and had charge of all contracts. The superstructure of the Richmond bridge was let to Tyndal and Channing Madison. As mentioned above, the bridge was designed by Wm. Dewey, and constructed under his supervision, and that of his

assistants, John Frazier, Jonathan Knight and Captain C. A. Ogden, The gorge of the Whitewater at this point is about 700 feet wide and 75 feet deep. This was too much of a gulf to be taken at one jump, consequently the bluff on the east was cut through, and a fill made to the water line; then on the west bank the road was placed on a shelf cut out of the solid rock, running along side of the bluff and on an ascending grade for some 500 or 600 feet, and then turning to the west, at right angles to its former course, cut through the remainder of the bluff. This gave large quantities of material, which was used in making the fill on the east approach; the bridge having been completed first. It is said that the grading of the approaches bankrupted several contractors, as did also the masonry. The latter work was finally completed by Benjamin Sayre. In excavating for the foundation of the east abutment, quicksand was encountered near the surface and large quantities of water, which was gotten rid of by means of an Archimedean screw, cut from a log by hand. Local tradition has long stated that the engineer and contractor finally scoured the country and bought all the wool obtainable in the region around, and dumping this in the quicksand, finally secured a firm foundation. But by some unbelievers this story is considered "woolley," and to lack foundation even more than the abutment did. The corroborating circumstance is the presence of quicksand, which was also encountered in constructing piers for the new bridge a few feet distant. At any rate, the masonry was planted on foundations dug deep and low, and so substantially made that it endured for 60 odd years. The abutments were about 30 feet high, the bridge being that distance above the water line. Each abutment had two curved wing walls and was constructed in a manner both substantial and presenting a beautiful appearance. Originally on each end of the wings were monuments giving an account of the building of the bridge. but these have long since disappeared. The entire wings and abutments were faced with first-class ashlar work; every stone squared, cut and dressed to a smooth surface, and with very thin joints. Little work is done today with a finish equal to this. Part of the stone used came from the bluffs in the near vicinity, and the remainder from a few miles down the river. All of it was stratified limestone, and after 65 years of withstanding the elements, it showed the effects of the weather. While the workmanship on the masonry was unsurpassed, the quality of the material obtainable was not equal to that of the bridge itself. The entire superstructure was of the very best white oak. It is remarkable for the clear lumber that it contains. Very many of the members do not show a single knot. Evidently the material was selected with the highest degree of care. The parts not exposed to the weather show not the slightest symptom of decay, having lasted for 65 years without renewal. This is interesting as showing the life of practical timber construction, and is a tribute to the value of good materials combined with honest workmanship. All lumber was gotten out by hand; the floor beams being hewn from solid logs, and the arches and truss members worked out by the old-fashioned whip-saw. All this was done on the "public square" at Richmond; the

bridge set up there and allowed to season a year before erection. The bridge was the combination arch and truss pattern; either system being strong enough to support the load. The span was 120 feet, divided into 12 panels. Two driveways were in the middle and a sidewalk on the outside of each. The arch system was composed of seven arches; 3 in the center and 2 between each roadway and sidewalk. Each arch was made up of two 4x10 feet pieces, bolted together at the panel points; the vertical truss members passing between them. A portion of the arch that was exposed to the weather decayed somewhat and was replaced in 1877, but the interior parts were sound and perfect to the last, although gradually becoming out of line. The floor beams were pieces 7x 10 feet, hewn directly from the logs as above mentioned. All bolts in the structure are hand made, having been fashioned in a blacksmith shop erected on the spot. The roof was supported at each panel point by turned pillars made in the first planing mill in the county, and are said to have cost $1.50 each. Above the sidewalks was a ceiling of boards, tongued and grooved and painted. Nothing was spared to make a structure elegant as well as useful. The total cost was about $6000, a large sum for the period; mechanics receiving $8.00 per month. Contractors apparently worked on as close a margin at that time as at present, as witness the bankrupting of several contractors before mentioned, and the fact that the subcontractors for the hewn timber, Joseph Rich and Thomas Kem, made a total profit of 37 1-2 cents, not counting their own labor. But in spite of these discouragements, honest work was done, as its long life bears witness. And its beauty was not less marked than its durability. The Richmond bridge had the reputation of being the "finest bridge west of the Alleghenies." It was one of the "wonders of the world" for the surrounding region, and many were the journeys made for the sole purpose of feasting the eyes on its attractions.

But all things have their day. The Old bridge, through which passed so much of the life and energy of the west, at length could no longer bear its burdens. The weight of years hung heavy upon it; sixty-five years of patient endurance of storm and rain and flood sapped its strength. It began to be whispered that the Old bridge was unsafe. But unmindful of these calumnies, it still stood and performed its duty. For many years after the first timid question of its safety was heard, it continued to bear loads of all degrees without a single failure. In 1895 the sidewalks were removed, relieving it of all unnecessary weight. The accompanying view shows it in this condition and hence does not do justice to its original appearance. The community was loath to lose an old land mark, but sentimental reasons for its retention did not prevail against the utilitarian spirit of the age. "The old order changeth, yielding place to new." The bridge was condemned, and its successor began to take form. Then, as though the Old bridge had only been sustained by a sense of duty, and was glad to lay its burden down, almost at the very time that work was begun on the new structure, a corner of the east abutment dropped out, undermined by the excessive flood of August 7, 1896, and the life of the Old bridge was over. It stood

for some months, a sad memento of its former usefulness, and upon the completion of the new bridge it was demolished and resolved into its original elements. The old land mark is gone and "the place which knew it once shall know it no more forever."

"Sic transit gloria mundi."

The Main street viaduct, the successor of the Old National bridge, is a deck structure consisting of 2 end spans of 39 feet 5 1-2 inches each; 2 intermediate spans, 80 feet 6 inches each; 2 intermediate spans, 80 feet 1 inch each; 1 channel span, 160 feet 2 inches; 4 tower bents, 20 feet 1-4 inch each; making a total length of 640 feet 4 inches.

The end bents, 1 and 10, are single bents, 23 feet high; the tower bents, 2 and 3, are 50 feet; 4 and 5 are 45 1-2 feet; 6 and 7 are 43 feet 8 inches, and 8 and 9 are 41 feet 2 inches high. All bents are of steel, resting upon sandstone piers, 4x4 feet at the top. Piers are covered with stone caps, 12 inches thick, 4 feet 6 inches by 4 feet 6 inches. Piers have a batter of 1-24, and extend down to bed rock, about 14 feet. The roadway is 30 feet wide in the clear and is paved with asphalt blocks upon 1 inch of sand and Portland cement concrete, 3 inches minimum and 6 inches maximum depth. The material was dumped at one end of the bridge and wheeled in on barrows and cost as follows:

Crushed stone, $1.50 per cubic yard.
Sand, 40 cents per cubic yard.
Gravel, 40 cents per cubic yard.
Cement (Buckeye), $2.20 per barrel.
Water, $19.50 total.

There were 2133 square yards of paving, requiring 267 cubic yards of concrete. The material cost, $.444 per square yard, and labor of laying, $.095, making total cost 54 cents per square yard. Furnishing and making the sandbed and laying the asphalt blocks cost 11 cents per square yard. The asphalt blocks are supposed to have cost about $1.45 per square yard, but there is no way of telling certainly, since all information on this point is safely locked within the bosoms of the County Commissioners. All that is known is that they paid $800.00 more for this floor than they were required by the terms of the contract to pay for a floor of red cedar block or vitrified brick, and brick would have cost us, including the filler, 95 cents per square yard, or $1.05 laid, which added to the cost of concrete given above, would have made the total cost of paving about $1.60 per square yard, instead of $2.00, the probable cost of the asphalt.

There are two sidewalks, one on each side of the bridge, each one 6 feet wide. They are paved with cement, laid on Portland cement foundation 2 1-2 inch minimum and 4 1-2 inch maximum depth, with a 1 1-2 inch top finish. Material cost as follows:

Crushed stone, $1.50 per cubic yard.
Gravel, 65 cents per cubic yard.
Sand, 75 cents per cubic yard.
Portland cement, $2.85 per barrel.

The cost to put this walk down was 10 cents per square foot and it makes a very cheap and a very fine piece of work.

The cost of the steel work in this viaduct was very close to $50,000. I am unable to give weights. The substructure was sublet and cost as follows:

Excavation, 30 cents per cubic yard.

Sand stone, F. O. B., $4.80 per cubic yard.

Stone masonry, including cost of stone, etc., $8.50 per cubic yard.

Concrete masonry, $4.00 per cubic yard.

Limestone coping, 14x30x60 inch, $2.15 per linear foot .

Limestone curbing, 5x20 inch, 60 cents per linear foot.

Cement sidewalks, 10 cents per square foot.

The total cost of masonry, fill, etc., was $11,631.44.

This makes a total cost of the viaduct $66,665.44, or $96.52 per linear foot for viaduct, and $27.00 per linear foot for approaches, or $81.29 per linear foot for the improvement, which is 820 feet long.

This viaduct is built upon a grade of 2.553 per cent., which detracts somewhat from its appearance. Nevertheless it affords a very practical means of crossing the Whitewater river and valley, although this grade was adopted much to the disappointment of the City Engineer, Mr. H. L. Weber. The plea of economy was the excuse given for this action, although had a 2 per cent. grade been adopted, it would only have cost $1,000 more, and would have given the bridge a nicer appearance, made an easier approach, fitted adjoining properties, and been better for all concerned. The average Board of County Commissioners is only equaled by the average City Council in the capacity for making serious blunders.

A PECULIAR BRIDGE.

I present a view herewith showing another bridge over Whitewater river near Richmond, Ind., which possesses some rather unusual features, as you will readily see. As was remarked by a resident of the vicinity—a gentleman noted for the force and aptness of his expressions—"it is like nothing, neither in the heavens above, nor on the earth beneath, nor in the waters under the earth." It was put up by the County Commissioners as an experiment, after urgent solicitation by the "inventor." The waterway is 200 feet; main span 150 feet. The inventor called it "a steel cable bridge," and besides the wire, it was composed principally af scrap iron and second-class gas pipe. His method of computing strains, proportioning the size of the cables, etc., was simplicity itself. Everything was based on Trautwine. For instance, if the tables gave the tensile strength of wire at 40 tons per square inch, and there should be only ten tons weight on the bridge, it is plainly evident that only one-fourth of a square inch of wire would be required, regardless of position, arrangements, moving load, moments, and other things introduced by engineers to mystify a person of common sense. The accompanying view shows the plan

of construction very well. The tower bents are of gas pipe, driven down by hand as far as they would go. The outside pipes extended up about 8 feet higher than the others, serving as towers, over which the upper cables passed and then divided, part passing to each panel point, where it was wrapped around a piece of pipe extending transversely under the floor. The lower cables, passing over the lower portion of the towers, supported the flooring, which was laid directly on them. The hand rail was of very flimsy character, and did not impart much stiffness to the bridge. The anchors were large bowlders, buried in the ground. The bridge was erected in 30 days, and cost for sub and superstructure complete, $2,150, of which the inventor stated that $800 was profit. This bridge presented a very peculiar appearance, and horses and other animals seemed to have an instinctive fear of it, and often could scarcely be persuaded to cross it. It was erected in 1889, and passed away in 1896. It is but fair to state, however, that for seven years it was in constant use, and carried some very heavy loads without failure, and its final destruction was caused by a flood of unprecedented magnitude for this region; the same that washed out the abutment of the National road bridge, referred to above, and which carried away barns, fences, horses and other stock, and inundated a portion of the city of Richmond, whose inhabitants had never even considered the possibility of such an event. The river had risen so as to run over the bridge floor, when a large tree, floating down, roots and all, struck about the center of the span, and the day of usefulness was over for that bridge. It is impossible to state which member gave way first, but the bridge was totally wrecked, and has never been rebuilt.

In this paper I have endeavored to give some idea of a few bridges, which illustrate three separate methods by which different people have solved the problem, "how to cross the Whitewater river." I hope I have not been too tiresome, and that some points herein may have been of interest to the engineer. Perhaps a retrospect of the past, and a contemplation of the present may be advantageous in the future, by showing what points to avoid and what to adopt.

PORTLAND CEMENT CONCRETE ARCHES.

W. H. PRATT, MT. VERNON, O.

Monoliths of Portland cement concrete, recently constructed in the shape of arches, culverts and bridges, scattered from the Atlantic to the Pacific through this country, indicate a wide-spread interest in this class of work. The essential properties of this artificial rock, when properly made from suitable materials, have long been recognized as comparing favorably with the same properties of stone used in masonry. The superiority of monolithic construction has received in this country less consideration than the inherent properties of concrete. The Germans were the pioneers in scientific cement making. They improved its quality and reduced its cost. With this people and their European neighbors we find concrete arches better understood and extensively used.

From special tests, and by noting the circumstances under which masonry fails, or remains intact, when subjected to heavy service and long exposure, we have derived certain principles, which enable us to determine, with more or less accuracy, its strength and durability. These principles govern our specifications for new work, and the every day practice of safely loading a single piece with many times the weight that might be trusted on the same material when most skillfully built up to the same size and shape with pieces laid in mortar.

In this climate the most active agent of destruction to masonry is the freezing of water in the joints. This is reduced, but by no means obviated, by the use of mortar which adheres strongly and which has small capacity for absorption. Mortar joints of all kinds are separators of a different nature, and bodies into which they enter can lay no claim to being homogeneous or to having connections as strong as the parts joined, characteristics so desirable, that they have become laws respected and observed wherever their application is possible. We every day acknowledge the advantages of continuity in materials whenever they are called upon to sustain loads or resist the effects of exposure.

Arches of segregated masonry may fail in three different ways: First, by the sliding of one arch stone upon another; second, by rotation about the edge of a joint; third, by the crushing of the arch stones.

In monolithic arches we have no arch stones to slide upon each other; we have no joints to open when the tendency to rotate about a joint on either surface occurs, and the tensile strength of the material opposite the point in question must be overcome before rotation can take place; we have no arch stones to crush, and, with material hav-

ing the same powers of resistance, the monolith would be stronger and many times more reliable.

The practice of building concrete arches much lighter than those of stone is supported by extensive tests and the stability of existing structures. Arches of segregated masonry will undoubtedly stand the heaviest loading near the time of their completion. With concrete arches the centers are usually struck in from four to six weeks after the placing of the concrete. Portland cement concrete in six months has more than four times the strength it had when four weeks old, and in one year more than four times the strength it had in six weeks. If the concrete arch will support itself when the centers are struck, we can reasonably rely upon its standing heavy service for centuries.

In the making of concrete we produce a material whose powers of resistance are definitely known within reasonable limits, and its uniformity in all directions enables us to more accurately proportion the quantity of material to the stresses it must resist. After considering the strength of this material, the absence of all elements for self-destruction, and its power to resist the effects of exposure, we must admit its permanent character. Concrete having a matrix of volcanic ashes and lime was the principal building material used by the Romans. This early Roman concrete was very inferior in all essentials to the material under discussion, still it has stood since before the Christian era, in conspicuous monuments of the enduring virtue of masonry witnout joints. The dome of the Pantheon at Rome, 142 feet in diameter and now nearly two thousand years old, is of concrete. Everything considered, it must be admitted that monolithic arches of good concrete are superior in strength and durability, even when a much smaller volume of material is used, for the same span and capacity, than the cut stone arches in common use. Ten years ago the cost of standard Portland cement made its use a luxury. The amount annually produced in this country was about 150,000 barrels, which was of a low standard, creating a prejudice which has been hard to overcome. During the last ten years its average cost to the consumer has fallen about 50 per cent. The amount produced in this country last year was 2,304,300 barrels, and the most exacting requirements are met by the leading brands of this domestic product. We continue to import from Germany over a million barrels a year, but England has failed to keep up with the times, and, in spite of the fact that her cements have been sold at a much lower price than the leading American brands, her exports to this country have fallen from 807,000 barrels in 1895 to 460,000 barrels in 1897. The reduction in cost of high grade Portland cement enables us to produce superior concrete suitable for monolithic construction several dollars per cubic yard less than we could produce it a few years ago; and monolithic concrete culverts and bridges which were with us an economic impossibility, can now be built in most localities for from 60 to 80 per cent. of the cost of those built with stone masonry. An ordinary high-

way bridge 40 to 70 feet span, with plank floors and stone masonry abutments, can usually be built 10 to 20 per cent. cheaper than a concrete arch, but when the cost of maintenance and renewals is taken into consideration the ratio is reversed. When buckle plate floors are used the concrete arch is found to be the cheaper structure. Concrete piers and abutments which will undoubtedly stand for centuries can be put in, when suitable sand and gravel is at hand, for much less than any other acceptable sub-structure.

Concrete arches are graceful and artistic in appearance, even when the faces are plain. The molds may be made to produce direct a great variety of ornamentation, or the work can be carved the same as natural stone. One of the most pleasing ornamental effects, and cheapest to produce, is that of ranged rock face stone work.

Imbedded iron and steel for supplying additional strength and supporting young concrete while soft has many advantages, and is extensively used. Since 1893 the business of building engineering structures, excepting government and municipal work, and in the wealthy Eastern cities, has been practically paralyzed. Notwithstanding this depression the concrete arch has made progress and spans up to 125 feet are scattered through the country.

The accepted classification of certain materials for certain purposes was disturbed by the reduction in the cost of iron. From bolts and nails it rapidly expanded with the force of a popular movement to innumerable uses, a few of which are of doubtful desirability and a few of which must be more in combination with other materials to be permanently demanded. The classification is now being disturbed by the reduction in the cost and the improvement in the quality of Portland cement, the consumption of which has annually increased in this country 10 per cent. since 1893.

The principal consumers of this cement will no doubt follow the painstaking methods pursued by the producers of the leading brands.

It is requisite that the builders of concrete arches have an intimate knowledge developed by systematic study and experience of the essential features of their construction.

The concrete sidewalk has been set back decades by incompetent builders putting down worthless flagging, and possibly the progress of the concrete arch may in like manner be somewhat retarded, but up to the present time the latter seems to have been in competent hands.

When the many claims of the concrete arch are considered, it seems, that its use will undoubtedly be extended, covering a field corresponding to that of its comparative short-lived fore-runner, the iron bridge, which now so universally mars the landscape.

DISCUSSION.

Mr. McKay: What is the cost per cubic yard for arch work?

Mr. Pratt: Its cost depends upon the variety of molds used. The average cost is a very hard question to answer, as the cost varies much in different localities. The distance for which the material has

to be hauled and the character and quality of work make prime factors in the cost. It would range all the way from four to ten dollars per yard, according to the location and character of the work and amount of ornamentation required.

Mr. Gilpatrick: Have you built any arches over small streams in your county? And if so, how long have they been in use?

Mr. Pratt: Yes; there are now five such arches in Knox county, and more are likely to be constructed, as demanded by circumstances. One of these arches has a span of 50 feet, and is located five miles west of Fredericktown, and has been in use two years. Four are culverts, of from 8 to 12 feet span. One is near Brandon on the Granville road, one on the New Delaware road just southwest of the Gambier street bridge, one four miles out of Mt. Vernon on the north Gambier road, and one on the Kinney road, about four miles from Mt. Vernon.

Senator Dodge: How high does it rise in the center with a 50-foot span?

Mr. Pratt: The lowest is a five-foot rise in 50 feet.

Senator Dodge: Do you use any iron to support it?

Mr. Pratt: Yes; we use 52-pound railroad rails, two feet apart.

TWENTIETH ANNUAL REPORT

OF THE

OHIO SOCIETY

OF

Surveyors and Civil Engineers

BEING THE

TRANSACTIONS OF THE SOCIETY

AT ITS

TWENTIETH ANNUAL MEETING

HELD IN PALACE HOTEL,

Cincinnati, Ohio, January 18, 19 and 20,

1899

OFFICERS, 1899.

President,
B. A. KEMMLER, COLUMBUS.

Vice-President,
HOMER C. WHITE, WARREN.

Secretary-Treasurer,
C. N. BROWN, COLUMBUS.

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PUBLIC HIGHWAYS.

ROBT. E. KLINE, Dayton.
F. J. CELLARIUS, Dayton.
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LAND SURVEYING AND DRAINAGE.

A. W. JONES, Chillicothe.
WM. DUNN, Zanesville.
D. W. SEITZ, Ottawa.

INSTRUMENTS AND EXHIBITS.

C. E. SHERMAN, Columbus.
A. C. BRETZ, Lancaster.
G. A. MCKAY, Xenia.

SANITARY ENGINEERING.

C. E. JUDSON, Sandusky.
EUGENE E. BOALT, Cleveland.
H. W. MCDONALD, Galion.

MUNICIPAL ENGINEERING.

HOSEA PAUL, Cuyahoga Falls.
J. B. STRAWN, Salem.
F. M. TURNER, Dayton.
C. H. BURGESS, Cleveland.
J. M. HARPER, Cincinnati.

RAILWAY ENGINEERING.

G. B. NICHOLSON, Cincinnati.
J. W. ATKINSON, Galion.
A. L. MORGAN, Zanesville.
W. H. PRATT, Chicago.

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TWENTIETH ANNUAL REPORT

OF THE

Ohio Society of Surveyors and Civil Engineers

MEETINGS HELD

At Palace Hotel, Cincinnati, Ohio.

OUTLINE OF PROCEEDINGS

Wednesday, January 18, 1899

2:45 P. M.

President Gilpatrick in the chair, C. N. Brown, Secretary.

The Secretary-Treasurer, Mr. C. N. Brown, read his Annual Reports, and the report of the Treasurer was referred to Board of Trustees for audit.

President was authorized to appoint a committee of three to draft suitable resolutions of sympathy respecting deceased members, in accordance with recommendation of the Secretary.

The Secretary requested that action upon his suggestion in regard to issuing certificates to new members be deferred until a later session, in order that it might have full discussion.

In response to inquiry by Mr. E. A. Kemmler, the cost of printing the Annual Reports was briefly considered, and the proposed consolidation of the 1898 and 1899 Reports approved by those present.

Report of Committee on Land Drainage read by its Chairman, J. W. Stump, Circleville. Discussion.

Communication from Harry M. Gates, C. E., Columbus, upon the subject of Railroad Construction throughout the world, was read by the Secretary, the same having been presented by Mr. Jones in lieu of other report by him as Chairman of Committee on Railroad Engineering. Discussion.

WEDNESDAY, 7:30 P. M.

President Gilpatrick in the chair.

Paper—"Land Surveying," read by G. A. McKay, Xenia. Discussion.

Report of Committee on Land Surveying read by its Chairman, J. D. Varney, Cleveland. Discussion.

Problem—"Land Surveying," by A. E. Bretz, Lancaster, in the absence of Mr. Bretz, on motion, was read by title and ordered printed.

J. D. Varney presented a problem in Land Surveying which had been the source of litigation. Discussion.

George H. Hill, Milford, presented problem in Land Surveying which had also been the subject of litigation. Discussion.

THURSDAY, JANUARY 19, 1899. 8:00 A. M.

President J. L. Gilpatrick in the chair, C. N. Brown. Secretary.

Report of Committee on City Engineering, Hosea Paul, Chairman, Cleveland. In the absence of Mr. Paul, read by the Secretary. Discussion.

Paper—"Street Pavements of Lima, Ohio," read by J. C. Cronley, Lima. Discussion.

Paper—"Maintenance of Asphalt Streets in Cincinnati," read by J. M. Harper, Cincinnati. Discussion.

Communication from J. S. Baker, of Cleveland, Ohio, referring to roadway construction adjacent to that city, was read by the Secretary. Discussion.

President Gilpatrick now named Messrs. J. D. Varney, G. A. McKay and E. A. Kemmler as Committe on Resolutions of Sympathy.

THURSDAY, 2:00 P. M.

President Gilpatrick delivered his address, and discussion followed.

Paper—"Construction and Cost of Roads in Brown County," read by C. M. Gordon, Georgetown. Discussion.

Paper—"Inter-Urban Electric Railroads Upon Public Highways," read by Robert E. Kline, Dayton. Discussion.

Report of Committee on Legislation, W. B. Gerrish, Chairman, Oberlin; in the absence of Mr. Gerrish, was read by the secretary. Discussion.

THURSDAY, 8:00 P. M.

The Society accepted an invitation extended by the Engineers' Club, of Cincinnati, for an informal reception and social at their quarters in the rooms of the Cincinnati Literary Club, of Cincinnati. The joint bodies were favored with an address by the Hon. Martin Dodge, Director of Bureau of Road Inquiry, on the subject of "Better Roads and Free Delivery of Mail." A vote of thanks was tendered the Senator.

Prof. L. A. Bauer, Chief of Division of Terrestial Magnetism, read a paper on "The Magnetic Survey and the Boundary Work of Maryland Geological Survey."

Refreshments and social enjoyment concluded the exercises of the evening.

FRIDAY, JANUARY 20, 1899, 8:00 A. M.

President J. L. Gilpatrick in the chair, C. N. Brown, Secretary.

President Gilpatrick named as Nominating Committee, Messrs. G. A. McKay, J. W. Stump and A. W. Jones.

In the absence of the author, the Secretary read a paper by O. W. Pfouts, Alliance, on "Sewage Disposal Works of Alliance, O."

A. W. Jones, Chillicothe, read an interesting, and at the same time amusing, paper on "Pneumatic Caisson Foundation for Main Street Bridge, Chillicothe, Ohio." Discussion.

Homer C. White, Warren, read a paper on "Water Purification." Discussion, in which, by invitation, Messrs. Charles A. Parmelie and Thomas W. Bohen participated.

E. A. Kemmler, Columbus, read a communication which he had prepared for incorporation in the Report on Sanitary Engineering, if approved by them; but had not expected to present as a formal report. He now read it at the request and in lieu of the written report by Mr. Weddell, Chairman of Committee on Sanitary Engineering. Discussion.

Frank A. Bone, Lebanon, as Chairman, made verbal report for Committee on Instruments and Exhibits.

The name of John Wm. Miller, Sandusky, Erie Co., Ohio, was presented for membership, recommended by C. A. Judson. On motion Mr. Miller was received into full membership.

Committee on Resolutions of Sympathy asked and were granted opportunity to prepare and transmit to the Secretary after adjournment of the convention, their report.

Committee on Nominations recommended the following as officers for the ensuing year: President, E. A. Kemmler; Vice President, Homer C. White; Secretary-Treasurer, C. N. Brown.

On ballot the ticket nominated was unanimously elected.

Mr. McKay reported for the Board of Trustees that the accounts of the Secretary-Treasurer had been duly audited and found correct. Report was approved.

Pursuant to the recommendation of President Gilpatrick, that the Legislature be memorialized to amend the statute providing for the State Board of Health, so as to have the Governor appoint as one of the members of said board a competent civil engineer, a motion to that effect was offered by J. C. Cronley, seconded by J. B. Weddell, and unanimously adopted.

Secretary Brown presented an invitation from Chas. A. Judson to the Society to meet in Sandusky next year.

Robert E. Kline of Dayton, urged the advisability of the selection of Columbus, because the Legislature will be in session about the time of the next annual meeting, and it will be desirable for this body to present certain matters to the Ohio Legislature while in session.

On motion of Mr. Kline, Columbus was selected as the place for holding the next annual meeting.

The Chair stated that the date of meeting would be arranged later by the Secretary.

On motion of Mr. McKay, seconded by Homer C. White, a unanimous vote of thanks was extended to the Engineers' Club of Cincinnati for their cordial hospitality and entertainment.

President J. L. Gilpatrick suggested that Bro. Harper be included in the vote, which suggestion met with general approval.

The Secretary called up the matter of issuing tickets of membership and the same was briefly discussed.

On motion of Robert E. Kline, the appointment of a committee by the President was authorized to correspond with various members of the Society, with a view to determining what action may be expedient concerning the issuance of certificates.

On motion of H. C. White, a unanimous vote of thanks was tendered the press of Cincinnati.

Retiring President Gilpatrick returned his warm thanks to the Society for the honor conferred upon him, of presiding over their deliberations during the past year, and offered congratulations upon the success of the present meeting and the valuable and interesting character of the papers presented.

On motion adjourned.

REPORT OF SECRETARY.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—I have the honor of submitting the following as the Annual Report of the Secretary for the Society year, January 15, 1898, to January 17, 1899.

The roll of membership is made up as follows:

Honorary Members	5
Active Members	88
Associate Members	3
Total Membership	96

It is unnecessary to inform you that the printed report of the 1898 meeting is not yet ready for distribution, because all are well aware of the fact. The blame for this rests entirely upon the Secretary who has charge of this work. The only excuse that can be offered is that during last spring and this fall my regular work has been so heavy that all other matters had to be laid to one side, and also that during the summer I was away from my home engaged in private work. During the session of the Legislature the Secretary's

office gave a great deal of attention to the bill providing for a Topographical Survey of the State, which might have otherwise gone to the publication of the report. But although the bill did not become a law it is thought that the time given to it was well spent.

The copy of the report is now ready for the printer with the exception of a few advertisements and can be finished in a short time.

Article 8, Section 7 of our Constitution provides among other things, that all members are entitled to a "Certificate of Membership" and some of the members have made requests for this certificate. No blanks or provision for such certificate was found among the Society property turned over to me, and upon correspondence with Mr. C. A. Judson, the Secretary preceding me, I learned that no provision had ever been made for them and that none had ever been issued.

It seems that we should either provide these certificates or change the Constitution. If it is thought best to provide them it would be well to appoint a committee to draw up a suitable and appropriate design for them. The matter is presented here so that it can be acted on at this meeting.

It is the sad duty of the Secretary to notify the Society of the death of three of its members, viz: G. S. Innis, A. L. Bliss and Otho Frield. In this connection it is also sad to note the death of Mr. F. J. Sager, who was one of the prime movers in the organization of this Society, who filled its various offices with marked ability at different times and who was one of its most active and energetic members for many years. For the last few years he had not been engaged in engineering work and so had withdrawn from the Society.

The usual exchanges are being made and have been partly distributed.

The Secretary wishes here to thank the members and especially the other officers and the chairmen of the committees for their help in securing the program for this meeting as well as in all other Society work.

Very respectfully submitted,

C. N. BROWN, Secretary.

REPORT OF TREASURER.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—I have the honor of submitting the following as the Annual Report of the Treasurer, for the Society year, from January 15, 1898, to January 17, 1899:

RECEIPTS.

Balance on hand from 1897	$6 35
Dues for 1893	5 00
Dues for 1894	5 00
Dues for 1895	10 00
Dues for 1896	20 00
Dues for 1897	36 00
Dues for 1898	157 00
Membership fees	28 00
Advertisements in Eighteenth Report, 1897	30 00
Advertisements in Nineteenth Report, 1898	5 00
Sale of Reports	2 00
Total receipts for 1898	$304 35

EXPENDITURES.

Balance on Printing Eighteenth Report, 1897	$28 62
Stenographer and Report of Eighteenth Meeting	67 10
Postage	46 00
Clerk Hire and Typewriting	48 10
Two Years Rent for Hall for meetings in Columbus	24 00
Express and Drayage	26 86
Office Supplies—Stationery, Circulars, Programs, etc	40 37
Expenses of Secretary to Cincinnati to arrange for meeting	9 30
Sundries	8 22
Total expenses for 1898	$298 57
Cash on hand	5 78
	$304 35

There are no unpaid bills standing against the Society.

There is a large sum due the Society for back dues of which thirty or forty dollars may be collected.

It is recommended that the annual dues remain as they have been for the next year.

Very respectfully submitted,

C. N. BROWN, Treasurer.

REPORT OF TRUSTEES.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen—The undersigned Trustees of this Society for the year 1898, have, in accordance with the Constitution, duly examined the reports and books of the Secretary-Treasurer, and beg leave to report that they find the footings to be correct and that proper vouchers for money paid out are on file.

(Signed) G. A. McKAY,
J. B. WEDDELL,
J. M. HARPER.

PRESIDENT'S ANNUAL ADDRESS.

JOHN L. GILPATRICK, GRANVILLE.

Gentlemen of the Society of Surveyors and Civil Engineers:

Four years ago it was the privilege of our Society to hold our annual meeting in this city. Those who were present at that meeting recall with pleasure the excellent program then presented and the untiring efforts of the Cincinnati members to make our visit agreeable and the meeting a success. So well were we entertained then, that, a year ago, when through Brother Harper, an invitation came to hold this session of the Society in Cincinnati, we promptly accepted it. And now, gentlemen of Cincinnati, we are here. The Secretary has arranged a very full program. Already we are well on with it.

We have come expecting a profitable session because every member present is here to contribute to the interest and profit of every part of the program.

I am sure that I express the sentiment of the Society when I say that it will be gratifying to us if engineers present who are not members of the Society and others will be free to engage in our discussion.

My attention has been directed to two or three topics to which I invite your attention.

DITCH LAWS AND DRAINAGE.

The securing of the granting of a petition for the construction of a township or county ditch is attended with so many difficulties that it becomes well-nigh impossible to obtain suitable drainage for many otherwise valuable tracts of land.

In many of our counties are small areas containing from 50 acres to one hundred acres of land, which, from their marshy character are not available for tillage. They are of little worth for pasture, a source of danger to stock during the wet seasons of the year, and from the masses of decaying vegetation growing upon them in summer, they become a menace to the health of the people in their vicinity. Many of these tracts can be completely drained; others only partially drained. They are often owned by men of small means, who are financially unable to fight reversals by the township trustees or county commissioners, and writs of injunction in the courts. These tracts are generally surrounded by valuable lands, which are supplied with the means of partial drainage and owned by well-to-do farmers, who offer every obstacle conceivable to prevent an improvement, which would make more productive their own lands and offer relief to the owners of these swampy tracts.

It would seem that the voluminous ditch laws now on our statute books ought to be sufficient to meet any emergency and perhaps they would, if properly interpreted. But, however that may be, there is need of new laws, or the enforcement of existing laws, or of both, which will ensure the drainage of such parcels of land, both for the health of the people in their immediate vicinity and for the general prosperity of the state. In some of these cases it will soon, if not alalready, become a proper subject of investigation by the State Board of Health. I submit the query: What can be done to overrule the obstructive tactics to drainage improvements.

The rapid growth of our country in population together with the cheapening in price of some farm products as a consequence of the extensive grain and stock raising in the western states makes it necessary for some one to devise ways and means whereby the tillers of the soil in the middle and eastern states shall be able to make "two blades of grass grow where now one grows." One element in the solution of this problem is better drainage. Better drainage requires better plans. Better plans must come from our engineers. They will not come from the Farmers' Institute. These better plans will follow from a more comprehensive study of the topography of the districts to be drained. The great trunk ditches and the smaller ditches should be articulated into systems as are the conduits for the drainage of cities and towns. When such plans are entered upon the farmer can drain his fields and find outlets for his tile without laying them on top of the ground.

Thousands of dollars are expended every year to construct new ditches and to maintain old ones, many of which are poorly located, and the alignment so faulty that the head which is small in consequence of a very low gradient is practically wasted in overcoming the loss in velocity of flow due to sharp and unnecessary bends. I do not forget that ditches are often located against the judgment of engineers in order to avoid trouble for trustees and commissioners. This class of difficulties is more frequently met with in counties where the land is rolling. But even in such level counties as Allen, Hancock, Henry, Wood and others, farmers will clamor to have the ditch follow the boundaries of their farms and turn "square corners" at any cost.

In counties like Licking, Coshocton and nearly all southeastern Ohio, the ditches are generally short, drain small areas, and frequently have small descent from source to outlet. It is in such regions that the most vigorous insistance will be made for the ditch line to bend around three sides of every potato patch and follow the tortuous track of the old channel, and for what good reason? None whatever. Nevertheless the line is established at the expense of a lower gradient, lower velocity of flow, increased length of line and consequent increase in expense of construction and of future maintenance.

RE-SURVEY OF THE STATE.

The lack of uniformity in the surveys of the different portions of the state has not escaped the attention of the members of this Society. In the northeastern portion of the state, we have the Connecticut Reserve; along the Ohio river is the Ohio Company's Purchase; in the southwest corner a small tract known as the Symmes' Purchase; in the west-central portion we find the Virginia Military Lands; beginning at the Scioto river in Franklin county, and extending east for a distance of forty-eight miles in a strip of land four and a half miles wide, called the Refugee Lands; in the east-central part of the state are the United States Military Lands, and finally within this last named portion is a tract known as the Licking Land Co.'s Purchase, comprising about thirty thousand acres, which was originally subdivided into hundred-acre lots. Another very annoying and much to be regretted fact is that many township corners and lot corners and also witness trees are lost completely, while those now in existence are disappearing rapidly.

I venture the suggestion that a re-survey of the state would be a very wise economy. A survey now made with modern appliances and methods would have many advantages over the primitive surveys in accuracy. The new monuments erected would serve as land marks for future sub-divisions. It would facilitate in a high degree the description of parcels of land in deeds of conveyance and especially on our country records. It would bring the entire state under one general system of land surveying, namely, the United States system, than which there is none better in this country at least. Future conveyances would be made by reference to the new survey. And thus many neighborhood quarrels over disputed lines followed by expensive litigation would be avoided. There are, no doubt, grave objections to a re-survey, but when all objections have been entered they will be found of small moment when compared with the advantages.

TOPOGRAPHICAL SURVEY.

A year ago considerable interest was taken in urging upon the attention of the Legislature the value of a topographical survey of the state. It will be remembered that the United States government proposed to bear part of the expense of the survey.

Every engineer interested in questions of drainage or water supply or road building of any sort, would find the topographical map of great value. In conjunction with the topographical survey and at small additional cost the land survey could be completed.

If we hold the same opinion concerning this matter today, that we held a year ago, then it would be well that measures be undertaken now to urge upon members of the Legislature the value of a topographical survey and the importance of making the necessary appropriation for the same. If the Society concurs in the opinion that a re-survey of the state is desirable for the purpose of having one

uniform method of describing the lands of the state, and for the purpose of establishing new monuments to govern in future sub-divisions then, it might be well to have a committee report a plan in furtherance of these ends.

LABOR AND MACHINERY.

The opposition of labor to machinery is proverbial. This opposition arises from an unwillingness on the part of the laboring man to change his line of work, from fear that he will lose his means of livelihood, from inability to adapt himself to new conditions, from a lack of intelligence to comprehend the advantages which will follow from the introduction of machinery and from a narrow and unwise selfishness.

These proportions are so evidently true that I can scarcely hope to escape censure at your hands, for naming them. My apology, however, for thus inviting your attention is this; we often forget the bearing of these propositions upon ourselves and upon our own interests. No one class can for any considerable time improve its own condition without contributing something to the general well-being of society. It is wholly within the range of possibilities that this Society both individually and collectively render important and effective service toward a more correct view of the relation and advantages of machinery to labor. If what we are pleased to call improvements in doing the work of the world are not improvements, then the world is moving backward and the condition of the human race in a state of barbarism is preferable to that which we enjoy. It goes without saying, that this body of men does not believe that improvements in machinery, improvements in methods, improvements in material are at variance with human progress in general, or with any desirable interest of the laboring man in particular. But it may be an open question as to whether or not, we are contributing our full share to the work of allaying the contention between labor and machinery.

It was a sad day for the coal heavers on the docks at Toledo and Sandusky when those great machines were started, which seized a 30-ton car of coal, lifted it to the top of an incline, turned it bottom-side up and poured the coal into chutes which conveyed the coal into the hold of the coal ship.

It was a sad day for those men when the machines were started. They sat on the docks filled with gloomy forebodings. They wondered where and how they would be able to earn the next sack of flour. Many were bitter and outspoken against the man who invented, against the men who built and against the companies who used these machines. The work of these coal heavers was heavy and wearing, and their wages were not large, but they were willing to accept the situation because it brought them bread. But now this means of livelihood was taken away. They are not quick to adjust themselves to new conditions, and they see little ahead but destitution and death, and so they decry these new applications of power.

But there is another side to this coal business. Up the lakes are great cities filled with people just as needy as these coal heavers. Over the treeless country adjacent to these lake cities are other people directly or indirectly dependent upon this coal for its power to keep them warm and to cook their food. Their dimes and their dollars are as dear to them as are the dimes and dollars of the coal heaver are dear to him. And when they give their dollars in exchange for coal, they want as much as possible, and they want it in as good condition as possible. These great machines make it possible to deliver the coal to the consumer in better condition and at less cost than when handled by these coal heavers. Thus for every 50 men idle by the operation of these machines, 5000 are benefited.

Twenty-five years ago the charcoal iron interests in this state were wrecked by the introduction of the cheaper process of making steel. The result of the change in the mode of making steel destroyed the industry of wood chopping and charcoal making. But the new steel industry developed rapidly along every line where soft iron had been used and onward into hundreds of hitherto untried fields, with the result that at once many times as many men were called for in the new industry as had been displaced from the old, while today the steel industry directly and indirectly furnishes employment for a thousand men where one was employed twenty-five years ago.

New uses of steel were suggested. These suggestions called for new machinery. The new machines many times multiplied by reason of the enormous quantities of the manufactured products called for, have furnished employment for the vast army of laborers.

Our wants both apparent and real have increased and are still increasing at an astounding rate. To gratify one want was to bring into existence a half dozen new wants.

To meet the demands of the appetite we call upon the provision merchants for the fish of the sea and the fruit of the southland. To gratify pride in dress our merchants each year must offer something new and more wonderful than has ever been looked upon before. Indeed the outfitter in every line is driven wild with the demands made upon him for somthing new, something varied in form, material and exquisiteness, something new in its purpose and in its power. And so the outfitter calls on the artisan for designs and he in turn drives the inventor to the construction of a machine to produce the article of his design which shall afford passing gratification to its possessor.

Now all this is well. The good, the true or the beautiful may be perverted, but it is well that as a people we have aspirations for that which at least seems to improve our condition and which in fact does in most cases benefit us.

But there are large numbers who forget that the introduction of machinery cheapens production and thereby brings within the ability of many to purchase not only the necessaries of life but large numbers of articles which gratify desire and contribute to our well-being.

They also forget that the use of machinery eliminates the severest human labor both in kind and amount.

Consider the reduction in the amount of hard labor in our agricultural industries due to machinery. What a gain to consumer, operator and miner also is the much-talked of and much-abused "coal tipple." It is impossible to estimate the amount of hard labor from which the laboring men connected with our mining interests of all kinds are saved by machinery. Many mining interests but for machinery would cease absolutely. Modern ship-building would be impossible if the element of machinery were eliminated. The battleship, which cost three million dollars, could not be built for three thousand millions, nor for any number of millions if we take from the hands of the workmen their machines. Our working men do not fully comprehend how far-reaching and how calamitous would be the results which would follow from the doing away with machinery. When they can be led to understand that machinery changes the channels and diminishes the severity of labor but does not diminish the amount of human labor we shall have fewer labor troubles.

When the horse-car first appeared on our streets it changed the cab driver to the car driver, when the trolley car displaced the horse-car the cab driver became the motorman and the stablemen in charge of the horses became the repairers and workmen about the car stables and the power plants. These new applications of machinery to transportation have been a boone to people of small means. The 5-cent fare enables them to ride where the charge for a carriage would have been prohibitive. The demands for quick transit were beyond the limits of animal power to supply. Electrical energy takes the place of animal power and armies of men are called for at the mines, other armies to transport and manufacture the copper and iron and still other armies to furnish equipment, to construct and operate the roads and assist the pu...c in using this new means of conveyance. But some one remarks that electricity has destroyed the horse-growing industry of the farmer. True, it is not what it was in the palmy days of the horse-car, but there will always be a demand for horses. And the farmer, like other laboring men, must adjust himself to the new conditions and avail himself of the greater comfort and of the cheaper and safer method of travel when the trolley car becomes as familiar in the country as now in the larger towns. It has been suggested that he will die in the adjustment. To this we can only say that if he is determined to die, if he will not make an effort to get out of the rut, to learn or to discover some new way of earning a dollar then we shall be compelled to say to him, "Farewell, Brother Crawford!"

If we do not assent to the doctrine of the survival of the fittest, we will agree that the greatest good to the greatest number should obtain.

I think that we are safe in concluding that the use of machinery lowers prices, lightens the labor of men, changes the kind of labor, stimulates desire so that the more we have the more we want, multi-

plies the varieties of employment and calls for higher degree of intelligence among all classes of workmen.

Labor troubles drive employers to discover ways and means whereby their business operations shall be independent of ignorant and sometimes insolent workingmen. These efforts result in new methods and new machines for doing work. The very beginnings of the applications of steel in ship-building in England were due to labor troubles, as set forth in an article on "Steel Foundation of the Ship-builder's Industry," in the December number of the Engineering Magazine. Directly the introduction of machinery in that industry enabled one man to do the work formerly done by a dozen men. But in a short time the prouucts of these machines come into such favor that multitudes of men of a higher order of intelligence and skill were employed in assembling these products into the great battleships. Energy intelligently directed brings things to pass. Men need to be trained to see things in their true relations. It is said that "the schoolmaster is abroad in the land." Well, we are glad he is, but if he were many times multiplied, there are many of us who would not receive his instruction. Many of us who would not in our boyhood, receive instruction from schoolmasters or others. Many of us who have had to be lashed and pounded by the world before we would try to learn. But there comes a time all too late for largest acquisition, when though our opportunity is meagre and our ability dwarfed we are glad to learn. It is to men of this class, that we of this organization owe a service. Our professional duties bring us in contact with men of nearly all trades. The severity of our duties at once puts us in touch with them. Our position makes us their leaders for the time. What we say to them is remembered and quoted by them. In these conversations quietly but purposely carried on, it is possible to explain to men who have been less favored than ourselves the relations of machinery to labor, of labor to capital, the difficulties which attend each, how many of their troubles are inevitable, while others may be easily overcome. We can interest and instruct many of these men, and help them to a better plane of living to greater productiveness so far as their labor is concerned, and to a higher order of citizenship.

REPORT OF COMMITTEE ON LAND DRAINAGE.

JOHN W. STUMP, CIRCLEVILLE, OHIO.

Mr. President and Members of the Society: The subject of land drainage has been one of great interest to the tillers of the soil for ages past and many are the methods used to rid the soil of its surplus of water, extending, if you please, from the leveling down of a few slight elevations on the surface in the course of the smaller streams to the building of dykes and pumping the water out. As a science the subject of land drainage has not received much attention, neither has it been discussed in farm journals or magazines until within the last few years. In fact the farmers themselves have not given the subject much thought until within the remembrance of any member of the society. The early settlers of our great state did not regard the flat lands of the northwest or the flat elevated portions of the south and east as being very valuable because the land was wet and had no natural outlet sufficient to drain the soil of its surplus of water. Hence the early settlers of our state choose to locate on the rolling portions along the larger streams. Later on it was found that these flat lands were just as productive as any if they could be drained.

In building public thoroughfares in the state, the land in these wet sections was drained to a noticeable extent by side ditches or trenches cut to get dirt to make the subgrade or fills, and many were the farmers who constructed small open drains leading into these side ditches. Further on large open ditches were constructed through the farms for the special purpose of draining the land of its surplus of water. But later it was found that to maintain an open ditch in good working order it required a great deal of valuable land and much care. So, many forms of underground drains have been devised, but none of them have proven very successful, either practically or financially, except the tile drain, and this only in the smaller ditches. Such drainage as is needed in some of our northwestern counties, tile will not suffice and open ditches must be maintained. In these counties large ditches are cut that resemble canals and are so large that it is impossible to tile them. The largest practical size of tile to be used, coming within the knowledge of the writer, are fifteen and eighteen-inch tile. Here in our section of the country the topography is such that it is cheaper to maintain open ditches that would require a larger tile than fifteen or eighten-inch tile, than by using a larger size.

Open ditches in slightly rolling districts receive the surface water quicker than a tile ditch, hence here an open ditch is more valuable to get rid of the flood water than a tile ditch. But when the ground has

become thoroughly saturated with water, open ditches are not very valuable outlets for water within the soil. In some parts of our county, Pickaway, where the ground is rolling, the excess of water within the soil remains there so long in the spring that a crop cannot be put in at the proper time without underground drainage or else work the ground while it is yet too wet. Knowing now that underground drains are better to take away the water within the soil than open drains, while open drains are better to take away the flood water on the surface than under drains, we have begun to use in our county both underground and open drains in conjunction. That is, the land is properly tiled throughout the entire basin with a shallow open drain constructed just over the tile. This open drain is given a grade like that of the tile, but it is made wide and not very deep, so that it can be easily farmed over, and yet take a great deal of the surface water. Open drains constructed as above over the main lines of the tile ditches are very valuable, as they will take one-fourth or more of the water that falls upon the ground, thus relieving the under drains of a great amount of work. It was thought at first by many of our land owners that to have a stream of water flowing down over the growing crops would be injurious to them, but experience has proven that no injury results. Our land owners all claim that the best crops are in these open drains over the tile ditches. This stream of water flowing in the open drains lasts but little longer than the storms, hence it is not likely that the growing crops will ever be destroyed or even damaged. In a dry season as we had last summer, the best corn in the fields grew in these open drains over the tile ditches, hence it cannot be maintained that a tile ditch is injurious to crops during a dry season. As there is no law bearing upon the construction of open drains over tile drains, these open drains are constructed and kept open by the land owners by mutual consent or by an article of agreement. We have one tile ditch here about three miles long that had no open drain constructed over the tile drain when the tile drain was laid. In places the tile is six and seven feet below the surface, but at the head the tile is about three feet deep. At the head of this ditch no trouble is experienced in getting the water away, but further down the water lies upon the surface so long that the crops are often destroyed before the surface water soaks away. Twice I have been called upon the line of this ditch, at different points, to see if there was not something wrong with the tile, as it did not do the work expected of it. I examined the tile carefully and found that it was laid nicely to a grade of one and one-quarter to one and one-half inches fall to one hundred feet and that when the water got into the tile it went away nicely. But a further examination revealed the fact that there was not a single lateral throughout the whole line of the ditch, that the tile were six and seven feet underground and imbedded three to four feet in a blue gravelly clay. I further noticed that there was no open drain over the tile drain, and that the only way the water could get away through the tile was to penetrate the ground through this blue clay. To do this would

take days and sometimes weeks for the water to get away. I recommended the construction of laterals every one hundred or one hundred and fifty feet and the construction of an open drain over the tile drain throughout the entire length of the ditch. The open drain has partly been constructed and a number of laterals put in, and already a change has been noticed. I have no fear as to good results after the open drain is constructed and a sufficient number of laterals are put in. A good many land owners in our section of country think that the land is sufficiently drained when the main line is constructed; that the water will come from all directions and enter the tile ditch and then pass on out into the main ditch very rapidly. This the water will do as rapidly as it can, but sometimes the tile ditch is so deep or the soil in which the tile is laid is so impervious to water that the growing crops will be destroyed before the surface water can penetrate the soil to get away through the main tile ditch. Now, if a sufficient number of laterals are constructed from two and one-half to three feet deep, the water will enter them rapidly and pass on out through the main ditch. Also if a shallow open drain is constructed over the main line the depth of earth over the tile is lessened and therefore the water can penetrate to the tile here more rapidly and get away, thus giving the very best practical results.

In the last few years quite a number of writers have expressed themselves as to how deep tile should be laid in the ground. Though we have engineered the construction of many a ditch, yet we have been unable to find a depth that would suit more than one case. In our section we are guided somewhat by the topography of the country and character of the soil, but mainly by the practical results to be obtained. If we get a good grade, we have to go quite deep in places, while at others we have to go quite shallow; if we go below our outlet we have trouble in keeping the tile free of silt and in good working order; if we place the tile too deep in a tenaceous soil, the growing crops are destroyed before the water can get away through the tile. For our main ditches we like to place the tile from 3 1-2 to 4 1-2 feet, and our laterals from 2 1-2 to 3 feet deep. It is rarely we get just what we want, for we have placed the tile in main lines less than 3 1-2 feet and greater than 4 1-2 feet.

If the soil is very porous we place the tile deep, so we can drain as large a territory as possible; if the soil is a clay tenacious soil, we place the tile shallow and the laterals from 60 to 75 feet apart. In establishing a grade we use whatever we can get. In some places we can get only about one inch fall, or less, to one hundred feet, while in other places we can get 2 to 3 inches fall to one hundred feet. The tile ditch mentioned above has a grade of about 1 1-4 inches fall to one hundred feet. It was necessary to put the tile in the ground from 6 to 7 feet deep for nearly 3-4 the length of the ditch in order to get an outlet. By going so deep the tile was laid in a blue gravelly clay, which is very impervious to water. The ditch was constructed in the winter of 1894-5 and but very little good has resulted to the farmers along the line of the ditch since its construction, because the tile is too deep for the kind of

soil, so that the water remains so long upon the surface that the crops are destroyed. It has often been said that the deeper the tile the better, but from our experience I have concluded that to obtain the best practical results, we should not go too deep, that is so deep as 5 to 7 feet, unless it is necessary to get an outlet for the main drains. A ditch constructed as last above mentioned will not only be very inactive, but will be very expensive, something which is very much desired to be avoided. When tiles are placed so very deep it will be necessary to construct a number of laterals at these places with a depth of 2 2-1 to 3 feet deep, so that the water may have a ready access to the main drains. In a porous soil, the deeper the tile the larger the area that will be drained; but there is a limit at which we must stop for, the larger the territory drained the longer the time will be to do it, and the time may be so long that the water will do more injury, as in the case mentioned above, than we will get good from the deep tile. Therefore, we must not put the tile in so deep as to prevent the water from getting away within a reasonable length of time, nor so shallow as not to drain a fair-sized area of land and aerate the soil well. When a ditch is to be constructed, care should be taken in locating the main drains as well as the laterals. No ditch should have sharp turns either vertically or horizontally. Also in locating an underground drain it should be so located that it will not only drain the soil of its surplus of water, but that it will get as much of the surface water as possible. In order to do this the under drains must be located as near as practical in the lowest ground. The surface water then will always be over the under drain and have the best possible chance to enter the tile. In this way the most of the surface water will soak into the soil and pass out through the tile, thus preventing a great deal of scouring on the main line of the ditch. Further, if the under drains are located in the lowest ground, they will drain a larger area than if they are not so located.

DISCUSSION.

J. C. Cronley: In placing 15-inch land tile in the ground, is there not danger of their cracking lengthwise, not from pressure, but from the cold air? We have had some experience in that way, and have about concluded that drains of that size should be sewer pipe.

J. W. Stump: We are using for sizes of 12-inch, 15-inch and 18-inch drains, sewer seconds 3-inch long. For smaller sized drains we use common land tile. We have never had any trouble with them. Our only trouble has been to get them laid properly. In some cases we have been compelled to take up and relay the pipe on solid foundation; but we have had no trouble from breakage from any cause.

President Gilpatrick: Mr. Stump refers to an important point when he comments upon the inefficiency of laws as to cleaning out of ditches. In the present state of the law would it not be advisable in such cases, instead of attempting any process for cleaning out under the law, to have a new petition proposing an entirely new route, rather than to go

through with the trouble of recleaning? I don't know whether that would be feasible.

J. W. Stump: We have had two cases of petitions for the cleaning out of a ditch where we could not very well put in a new ditch, because there was already a county ditch. One petition was for the cleaning out of 160 rods. We could not find any law upon the subject of county ditch cleaning out, so we are proceeding by mutual consent of the landholders.

President Gilpatrick: Could not a petition be started to lay a ditch along that particular line, starting new, saying nothing about the old ditch?

J. C. Cronley: That could be done, and is done very often.

J. W. Stump: It is already a county ditch. Could there be another county ditch on the same line?

J. C. Cronley: In our county and in the adjoining counties of Van Wert, Hancock and Putnam that has been done. Mr. Stump's idea of combining both the tile and open ditch is my solution of the whole ditching problem, except as to the outlet. A year or two ago we had 7000 feet of tile put in; the petition in the first place called for an open ditch. I advised the party to let me make a tile ditch, and I would leave an open space above through which the surface water could flow; and when no surface water was there the tile would carry off the other. Every 200 feet we placed an inlet at the bottom of the old ditch, with a grate over it. I watched that ditch for two or three years, and it has worked as well as anything can work ever since it was constructed.

President Gilpatrick: How are those drops constructed? Do you simply place tile on end?

J. C. Cronley: We had 12-inch tile in that ditch, and every 200 feet we placed a tile upright over a 6-inch hole in the ditch tiling extending up to the bottom of the open ditch above, and covered by a perforated grate or lid. We had no trouble with the lids. The only trouble was the outlet. The ditch was through quicksand, and they told me it would be imposoible to tile that. They said it was tried before, and was a failure. I made the contractor wait until real dry weather, some time in the last of August, and began at the outlet of the open ditch and cleaned that out. When we came up to where the tile was to begin, the ditch was dry. Where the quicksand was it was as hard as a floor. We laid the tile and placed long grass around each joint, and took the clay from the top of the ditch and placed it on the sides and on top, covering the tile and then loose stuff on top. It has kept in place ever since.

President Gilpatrick: I would ask Mr. Stump if he had any trouble with his ditch, cutting down to the line of the tile and uncovering it?

J. W. Stump: We have had no such trouble as yet.

LAND DRAINAGE IN SENECA COUNTY.

CHAS. J. PETERS, TIFFIN.

There have been approximately 10,000 feet of tile and 10 1-2 miles of open ditch constructed in Seneca county during the year of 1898, under petitions to the County Commissioners for county ditches. The tile used were about one-half sewer pipe (seconds) and the other half common drain tile, ranging in sizes from 4-inch to 12-inch.

The County Commissioners have furnished nearly 7 miles of tile to private parties and to the township trustees of the several townships, ranging in sizes from 6-inch to 30-inch, mostly sewer pipe. I don't consider this plan commendable for the reason that the tile in a great many cases are poorly laid, and the proper care and judgment is not generally exercised in determining the sizes of tile used. Besides there is no proper record of where the tile are laid, their depth, size, kind or alignment.

Of the 10 1-2 miles of open ditch about 6 miles were deepening and widening, 3 miles new and 1 1-2 miles cleaning out under the statute providing for the apportionment to be made in sections of labor proportional to the original assessments. I am very thankful that there was but one job of the latter kind. I consider the law for cleaning ditches very impractical.

Seneca county has about all of the open ditches of any considerable size it needs. The future work will be to deepen and widen a great many that were originally constructed too shallow, and a great many that have practically filled up on account of the little fall they have together with the negligence of the land owners.

I have made some effort to formulate some tables for the size of tile, depth, gradient, etc., for tile ditches, but have found it what I consider an impractical task for the reason that the conditions to be met are too numerous. In fact, it is very extraordinary to find even two cases where the conditions are exactly the same. The nature of the soil and subsoil, the natural lay of the land, artificial collecting channels, the alignment and gradient of the drain, etc., are all factors which must be considered. Besides it is not always good economy and practice to provide a drain either open or tile (more particularly tile) of sufficient capacity to carry all the water as fast as it falls in extremely heavy rains. The conclusion that I came to is that: An engineer should become familiar with the contours of the area to be drained, the nature of the soil, the fall and alignment of the drain. He should know what the land is to be used for. Then if he is somewhat of an agriculturist besides, he will be able to specify a proper drain economically.

Generally speaking, I favor laying tile from 1 1-2 feet to 3 feet deep in the bottom of open ditches. This will keep the bottom of the open

ditch dry except in very wet times, and prevent weeds and swamp grass from growing. It will also provide a safe outlet for lateral tile drains and still have the advantages of an open ditch in freshets.

I favor making open ditches deep with narrow bottoms. By confining the current to a narrow channel, it will necessarily be deeper and stronger and will clean the ditch better.

I favor laying tile deep and avoiding abrupt turns or many and providing plenty of durable inlets. A drain thus designed will carry much more water than even a much larger one with those points neglected.

A BRIEF REVIEW OF SOME OF THE IMPORTANT SANITARY PROJECTS WHICH HAVE BEEN UNDER CONSTRUCTION DURING THE PAST YEAR.

E. A. KEMMLER, COLUMBUS.

I. THE CHICAGO DRAINAGE CANAL.

Work on this great enterprise was commenced in September, 1892. According to present estimates it will be completed by July, 1900. The only work unfinished at this time is the construction of bridges and controlling works at the lower end. Total expenditure to date, exclusive of interest, $22,616,781; estimated balance required to complete the work, $5,225,649.

Work on this project was greatly hampered during the past year by endless and unlooked for litigation, so that the progress made has fallen far short of anticipation, and will prevent its completion during the present year, as was expected.

There is more trouble brewing for the Drainage Commission at St. Louis and the towns along the Illinois river, on account of the unwholesome effect, supposed or real, which the sewage of Chicago (borne by this canal, and diluted in the ratio of sixteen to one with Lake Michigan water) will have upon the water supplies of these towns and cities.

St. Louis pumps its water supply directly from the Mississippi, and a committee of prominent public men of that city has been appointed to investigate the subject of pollution, while at Chicago the Commissioner of Health has urged the trustees of the sanitary district to institute a series of bacteriological and chemical examinations of samples of water collected at various points between Chicago and St. Louis before and after the canal is put in operation.

It is to be hoped that this advice will be followed, as such a series of tests would add an interesting chapter to our knowledge on the self-purification of streams.

II. METROPOLITAN SEWERAGE SYSTEMS OF MASSACHUSETTS.

The Metropolitan Sewerage Commission was created by the Massachusetts legislature in 1889. Its purpose was to devise and execute

plans for a system of intercepting sewers, for collecting and removing to points of disposal, the sewage of all the smaller towns in the immediate vicinity of Boston, in order to prevent the pollution of streams.

The work of construction was commenced in 1890.

The sewers were designed to carry the house sewage (225 gallons per capita) of the estimated population in 1930, which would be about double that of 1890.

From the last annual report of the commission, we find that the works constructed now include three distinct systems of intercepting sewers, having a total length of about sixty-five miles and serving 20 separate municipalities.

All the sewage is pumped. Part of it is disposed of by the city of Boston at Moon Island, together with the sewage of the Boston main drainage system.

III. NEW ORLEANS DRAINAGE SYSTEM.

This unique system of covered drainage canals, designed to lower ground water 5 and 6 feet, is now under construction at New Orleans, Pumping stations will be established at the lower ends of the canals and the entire flow lifted into the river.

The system is estimated to cost 6 to 7 millions, and will require five years for completion

New Orleans is still without a system of sanitary sewers, and in this respect has only one rival among the larger cities of the United States, namely, Baltimore. However, a beginning was made six years ago. The system was designed by Rudolph Hering on the separate plan, which was adopted, not from choice, but from necessity. The construction was begun by a corporation which had obtained a franchise from the city, but for some reason (financial failure, apparently) work was discontinued after a few miles of sewers had been built.

The city is now, as it were, in the hands of the "Philistines," both as to water supply and sewerage. The private water company with which it is afflicted has not proven an unqualified blessing, and the sewerage company does not propose to have its franchises annulled without desperate resistance. In February next, the citizens will vote upon a proposition to borrow $9,000,000 to be expended for sewerage, drainage and water supply; if the vote should be against the loan, the old order of things will continue to exist and the germs of yellow fever and other diseases will have a new lease on life in that city.

IV. OUR COLONIES.

At the close of the war with Spain, our government commenced its missionary work in the field of sanitary engineering, notably at Santiago and Havana. The latter, according to the report of the late Col. Waring, would be a healthy place to keep out of at the present time. Eight measures were recommended as being necessary to render the city safe and habitable for human life.

1. Clean the streets.

2. Construct a sanitary sewerage system and clarify the sewage before pumping it into the harbor.

3 Empty all cesspools and privies and fill them with clean earth; connect all houses with the sewers and introduce modern plumbing.

4. Pave all the streets with asphalt in order to make them impervious.

5. Erect a new slaughter house.

6. Construct garbage furnaces.

7. Reclaim all the marshes by drainage, diking and pumping.

8. Install the necessary power plant for pumping.

Roughly estimated, the above work is to cost $10,000,000. It might be added, that these recommendations could be carried out without harmful results by a number of American cities.

Two new methods of sewage treatment which have gained prominence during the past year, namely, the septic system and that of double filtration, should be mentioned in this report.

The septic system has been developed in England. It has not been tried in this country, but has been recommended to a number of American cities by sanitary experts.

The system as used by the patentee, Donald Cameron of Exeter, England, consists of a series of air-tight reservoirs, built of concrete, into the ground, arched over and covered with sod. These reservoirs, called septic tanks, are 64 feet long, 18 feet wide and 7 feet deep, and have a capacity of 65,000 gallons. The sewage was turned into the tanks and left there 24 hours. During this time the so-called anaerobic bacteria disintegrated the sewage, and the following biological changes took place:

Oxidizable organic matter in solution was reduced...	30.8 per cent.
Free ammonia	26.9 per cent.
Albuminoid ammonia	17.5 per cent.
Suspended solids	55 per cent.

The effluent was then allowed to flow over filter beds, where the aerobic bacteria completed the work of purification.

The system of double filtration is as yet comparatively untried, but seems to be very promising.

One form of it has been tried at Reading, Pa., but with indifferent success. The crude sewage is first strained through coke and then pumped to the filter beds. The filtering material is sand. The beds are constructed in pairs, one above the other. The strained sewage passes over the upper bed first, from which it drops through an air space on the lower. It was claimed for the system that the sewage would be purified at the rate of 8,712,000 gallons per acre per day, but the results have not panned out as expected.

An improvement over the plans just described has been proposed for the purification of the sewage of Columbus, O. The material for both straining and filtering will be coke.

After passing through the coke strainer the sewage will be led successively through coarse and fine-grained biological coke filter beds. The action will be intermittent, instead of continuous, as at Reading.

Six other projects for the purification of the sewage have been studied and estimated, as follows:

1.	Broad irrigation and intermittent filtration, estimated cost..	$524,528
	Cost of operation	44,735
2.	Chemical precipitation and coke filtration, cost	342,244
	Operation	42,292
3.	Chemical precipitation and sand filtration, cost	550,518
	Operation	61,314
4.	Ferrazone-Polarite system, cost	487,000
	Operation	46,780
5.	Septic tank system, cost	579,795
	Operation	46,780
6.	Coke filtration and land filtration, cost	542,396
	Operation	45,128

The plan recommended, mechanical straining and double coke filtration, was estimated to cost $508,600; operation, $36,973.

The advantages claimed for this method are its low cost of operation and small outlay for land.

In conclusion I may state that the demand for better sanitary service in our cities is constantly growing. Sanitary engineers are being called on to give advise where a year or two ago experts were looked upon with contempt. The great obstacle to the carrying out of the plans of systematic sanitary improvements, especially in the large, over-taxed cities, is the lack of available funds. A method of distributing the cost, which promises to surmount this obstacle, has been introduced in Brockton and Boston, Mass. It is called the "Rental System." The cost of lateral sewers is assessed upon the abutting property, as heretofore, but the funds for the main sewers and disposal works are raised by the sale of bonds. The money for the payment of the interest and sinking fund is derived from rents, the amount for each house being based upon the amount of water consumed.

The "rental system" has also been recommended to the city of Baltimore by its sewage commission.

SEWER CONSTRUCTION AT SHELBY.

J. B. WEDDELL.

Our main sewers are about three and a half miles long, and were contracted for about a year ago. They were commenced last March, and the laying has just been completed. The accessories and some other work is yet to be uone. There are some things connected with the work that may be of interest to the Society. The pipe was furnished by the National Sewer Pipe Co. The outlet was 18 inches and the branches were 12 inches. Much of the 18-inch pipe supplied I considered was unfit to be used. The pipe company took great exception to the inspection and to the culling of the pipe. Pipe was furnished in 2 1-2 foot lengths; much of that was blistered in places as large as your hand, and had other defects, which, considering that the work was at depths of 14, 16 and 17 feet, I felt that we wanted the best material we could get. Out of the quantity sent—about 12,300 feet of that kind of pipe, some 1900 feet was rejected, or about one-sixth of it. The result was that they attempted to boycott the town, but failed. For the main line sewers most of the pipe furnished was in 2 1-2 foot lengths, but they ran out of that at one time and furnished some 3-foot lengths. I never saw any nicer pipe than those 3-foot lengths. That lot was comparatively free from any of the defects complained of in the other pipe, and in all that carload there was not a half dozen pipe rejected, and those were rejected simply because they would not fit. Some 15 or 20 years ago we were inclined to doubt the wisdom of using pipe over 15 inches in diameter, and therefore sewers of larger diameter were built of brick; but now pipe is used for larger diameters of sewers because of the more perfect output of the factories. In fact I believe that as now made, sewer pipe are the best thing today that can be put into the ground.

We have had a good deal of high water and floods everywhere, yet our work is standing nicely. We had to cross and recross a stream about 30 feet wide, and with water running in it from two to four feet deep at ordinary stage of water. At one place on this stream the sewer was carried along side of the channel for several hundred feet. We carried our sewer through just on the grade, and when we came to cross the stream, we put under the overflows that came into contact with the water, iron pipes; then in the stream, that low stages of water might be carried off when it didn't go over the top, we provided pipes in the channel so that the water would flow through those in ordinary stages of water without causing any damage. Then we riprapped that all over; there was a good deal of that kind of work put in, so that we have it quite well bonded; and this high water has shown that our riprap is standing just as good as when we put it in.

I feel that we ought to consider all improvements well, and put them in at just as low a cost as possible, so as to get within the reach of the people. I have felt tnat the expense which has attended the building of sewage filters was unwarranted. In building a filter, it is usual to make an excavation about 4 feet deep and refill it with suitable material, such as gravel, sand, broken stone, or all of them, which makes the filter very expensive. Now it is the top of the filters that becomes foul, and has to be renewed from time to time. If that is true, what is the use of all the material below? We have our under drainage which is carried off, and a mass of material on top, which is all that becomes foul and has to be replaced. Now, why should we put more in below than we need, more than ever will be used? Wny not lessen the cost of that? Accordingly I presented a plan to the State Board of Health, making the excavation 18 inches deep at one point, and 2 feet at another. There is a trench a foot square exactly at the upper end and 12 by 18 inches at the other end, allowing a fall in the line, with a 4-inch pipe in the bottom as an under-drain, carrying off and intersecting with another pipe that enters the sewer. Then fill the first 12 inches with clean sand and the balance with suitable gravel, filling the trench also with it. When you consider the cost of that compared with the cost of the other, you are saving at least 50 per cent. in cost of construction. I don't know whether the State Board of Health would approve that or not. From my experience in a meeting with them, I found that the board were very careful about these matters, as they should be. I sent them a plan, and received a letter from the secretary saying that the thickness of the bed was very much less than ordinary, but that possibly it might do. They gave their approval to the construction with this suggestion, that the excavation for filters be made deep enough so that if the filter proved not to do its work that the depth would be there for a thicker filter. A bed 60 feet wide and 150 feet long can be constructed after this manner for about $700.00 or $800.00, whereas in the old way it would take from $1600.00 to $1800.00, depending upon the cost of material. I feel that for towns the size of Shelby, or twice its size, you will find a filter of this kind will answer probably just as well as the more expensive one. Shelby has about six or seven thousand inhabitants. When you make estimates for such towns for filters and disposal plants, the price is always the thing which looms up so as to frighten them; therefore in offering this design, you will be giving them something within their reach, and should it prove unsatisfactory you can remedy it. We have about seven miles of laterals now in process of construction.

DISCUSSION.

H. C. White: I would like to ask if Mr. Weddell has tried this filter?

J. B. Weddell: I expect to build them in the spring.

H. C. White: Could you not test it by building a small filter, trying it and having analyses made?

J. B. Weddell: We may manufacture some sewage or get some about what we think it will be; but I have such confidence in it I think it will last finely for 25 years even without any repairing.

Secretary Brown: Do you have more than one bed?

J. B. Weddell: They have to have at least two for the purpose of alternating, so the sludge beds can be cleaned. Our sludge beds are [illegible] dug out of the ground about [illegible] to [illegible] feet in length, and probably [illegible] or 4 feet deep, covered with planks. The sludge will run in there and is held until emptied, and will be deodorized. The man who lives on the farm there takes care of the sewage for the rent of the farm, and will carry it right out and plough it under; so that outside of the original cost of the farm, the expense of taking care of the sewage isn't anything.

President Gilpatrick: As a matter of convenience and economy, in cleaning out the sludge from those beds, wouldn't it be cheaper and better to line the excavation with plank?

J. B. Weddell: No, I think not.

President Gilpatrick: That seemed to be the experience at Oberlin. They built them as Mr. Weddell suggests, but soon found that the scouring off was so troublesome, that they lined those with plank. I think the excavations there are not more than 2 or 3 feet deep.

J. B. Weddell: Plank is perishable and becomes foul. Probably concrete would be better.

J. C. Cronley: Did you have a contingent outlet?

J. B. Weddell: Yes, sir; we have that. The state board objected very much to that contingent outlet; they said it was something like a contingent water supply, you never knew exactly what you were going to get. I cited them to the fact that I did not know of a system anywhere that had not a contingent outlet.

REPORT OF SEWAGE DISPOSAL WORKS AT ALLIANCE, OHIO.

O. W. PFOUTS, ALLIANCE.

At the Society's last annual meeting at Columbus, Ohio, a complete description of the Alliance Sewage Disposal Works was given. (See report of Ohio Society of Surveyors and Civil Engineers of 1898, page 88.) This report will be a comparison of this year's and last year's results.

Cost of operation, coal consumption, amount of chemicals used (lime is the only chemical used at the Alliance works), and other items of expense.

COST OF OPERATING THE ALLIANCE DISPOSAL WORKS:

	1897	1898
Labor	$838 77	$861 01
Coal	195 90	272 73
Chemicals (Lime)	132 34	249 96
Oil, Waste and Packing	16 07	18 41
Filter Clothes	66 26	79 40
Repairs	30 36	*83 53
Miscellaneous	11 05	2 40
Totals	$1290 75	$1567 43

*Replaced wood slacking vat with iron one.

On January 1, 1897, there were 65 house connections to the sanitary sewer system. January 1, 1898, the number had increased to 175, and January 1, 1899, to 265.

To ascertain a number which would represent the number of connections for one year's flow, it is necessary to refer to the dates of constructing the different connections. It will be readily seen that a connection made in January would operate for over eleven months of that same year, while a connection made in December would operate for less than one month.

These references were made and the average number ascertained, which number represents the number of house connections to the sanitary sewer system in operation for one year, and is for 1897, 117; 1898, 218.

All averages are calculated from these numbers of sewer connections.

	1897	1898
No. of Days in Operation	365	365
No. of Sewer Connections, running 1 yr. (Av)	117	218
Total Operating Expenses, 1 yr	$1290.75	1567.43
" " " 1 day	3.54	4.294
" " " 1 day, 1 connect.	0.0302	0.0197
Coal Used (in lbs.) 1 yr	290000.	388000.
" " 1 day	794.	1063.
" " 1 day, 1 connection	6.79	4.87
Lime (in lbs.) 1 yr	65700.	124950.
" " 1 day	180.	342.
" " 1 day, 1 connection	1 53	1.57
Organic Matter Extracted from Sewage and Pressed at Works (in lbs.) 1 yr	171550.00	327050.00
" " " 1 day	470 00	896.00
" " " 1 day, 1 con.	4.01	4.11
Sludge (Lime and Organic Matter) (in lbs. 1 yr	237250.00	452000.00
" 1 day	650.00	1238.00
" 1 day, 1 connection	5.55	5.67

No new construction on the works, or any new improvement of grounds was undertaken. Everything about the works and grounds is in first-class condition, the laborers at the works being able to keep the grounds in condition.

The entire cost of constructing the Alliance Sewage Disposal Works, up to date is $20,755.62. A distinction should always be made between operating expenses and maintenance expenses; the first cost of the plant may be too high or too low. Interest on bonds varies with different towns, and a number of reasons could be given for making this distinction. The cost of operation is the vital point, as it is on the merits of the plant that these costs largely depend.

This paper presents both cost of operation and of maintenance, as the author considers them.

Cost of maintenance—Sewage Disposal Works, Alliance, Ohio:

	1897	1898
Operating Expenses	$1290 75	$1567 43
Interest on Bonds	1000 00	1000 00
Total Cost of Maintenance (one year)	$2290 75	$2567 43
Total Cost of Maintenance (one day)	6 28	7 03
Total Cost of Maintenance (one day), one conn	0 0536	0 0322

It will be seen from the above tables that the operating expenses increased 21 4-10 per cent. over last year, while the cost per con-

nection, per day decreased 34 8-10 per cent., and the coal consumption, per connection per day, decreased 28 2-10 per cent.

The organic matter precipitated, collected, and disposed of, has remained constant, or nearly so.

THE PURIFICATION OF WATER.

HOMER C. WHITE, WARREN.

The object of this paper is to call the attention of the Society to work that has been done at Pittsburg, Pa., with a view to supply the city with pure water.

As is well known, the experiments at Pittsburg were conducted with various types of filters, owned by competing companies, and no information in regard to the results of the experiments has, at any time, been obtainable from the officials in charge and will not be until the publication of their report, which is expected shortly. The information in the following paper has been obtained from various articles published in the newspapers of Pittsburg.

In 1896 the city councils of Pittsburg appointed a commission to examine the water supply of the city. The duties of the commission are set forth in the following resolution, which was adopted by councils: "Resolved further, that it shall be the duty of this commission to thoroughly investigate as to the character of our present water supply in its relation to public health, the effect of sand filtration and the advisability of establishing a sand filtration plant for the city of Pittsburg, with an estimate of the cost of establishing and maintaining the same; and also to investigate the feasibility and advisability of seeking other sources of supply. And the commission shall report its findings and recommendations together with such evidence as may be useful for the guidance of these councils in acting prudently and for the best public interest in this matter."

The commission is composed of the following gentlemen: Robert Pitcairn, chairman; Dr. W. J. Holland, Mayor H. P. Ford, S. D. Warmcastle, president of select council; George L. Holliday, president of common council; Senator William Flinn, Director E. M. Bigelow, James M. Bailey, William McConway, Dr. James R. Vincent and Dr. J. Guy McCandless.

Various sums of money have been appropriated by councils for the use of the commission, aggregating up to the present time about thirty-five thousand dollars.

Experts were employed by the commission as follows:

Allen Hazen of New York, as consulting engineer; Morris Knowles, formerly of the Metropolitan Water Board of Boston, resident engineer; Dr. Walter Riddle, chief chemist; and Mr. Copeland, formerly of the

laboratory of the State Board of Health of Massachusetts, at Lawrence, Mass., bacteriologist. These officials are assisted in the laboratories and experiments by three or four attendants.

The work of the experts was begun during the summer of 1897 and since June of that year samples have been taken from the Allegheny and Monongahela rivers and some springs and wells.

A partial report of the commission to councils made in January, 1898, showed that samples of water used by Pittsburg residents for drinking purposes have been examined by expert chemists and engineers for the past eight months. Reports of their findings have been made regularly to the commission, the members of which have met every week for a long time in their endeavor to devise ways and means for pure water in Allegheny county.

Channcellor W. J. Holland of the Western university,who is a member of the commission and chairman of the subcommittee on water analysis, said to a member of the press:

"The water of our rivers and springs have been subjected to a most careful examination, chemically and bacteriologically, since last June (1897). Experiments in filtration by several methods under the most approved scientific conditions have been carried on and have yielded interesting results. * * * * The results will all be embodied in the final report, which will have large practical and scientific value, and will be interesting to the public at large. * * * Already the most polluted water that has been examined by the chemists for the commission has been made 99 1-2 per cent. pure * * *"

The final report of the commission is about ready to be presented to councils. I am informed that it will contain a complete history of the experiments and that it is expected that it will be published for the benefit of the public and issued in pamphlet form.

The following statement was made by resident engineer Knowles, to the press, which appeared in the Dispatch July 24, 1897:

"The Filtration Commission, by the ordinance creating it, was instructed to investigate the feasibility and cost of purifying the Pittsburg water by sand filtration and by any other process which might appear suitable for that purpose. Sand filtration is in use in a number of American and a much larger number of European cities, and sufficient data as to the results obtained from it and the cost of installation and operation in many of these places are available. Some special conditions, however, were found in Pittsburg, which make it desirable to make a practicable test of the system upon a sufficient scale to determine just what can be done with the Allegheny river water.

"The Allegheny river receives a certain amount of mine drainage, which is different from anything discharged into the Merrimac, the Hudson, or other rivers which have thus far been successfully filtered in this country, and it carries at times a large amount of sediment. It is thus important to determine whether or not there is any element in the Allegheny river water which renders its filtration difficult or impossible.

"It is also important to determine what rate of filtration can be successfully used with the sands available at Pittsburgh as this will control the area of filter beds required. Another important matter to be settled is whether or not it will be necessary to remove some of the mud from the water before taking it to the filter. In some of the European cities such a preliminary treatment has been found advantageous, while at Lawrence, Mass., and at Poughkeepsie, N. Y., with river water carrying only comparatively small quantities of sediment, such treatment has not been found necessary. In order to settle these and similar questions the filtration commission has erected its Experimental Filter Purification Plant.

This plant consists of a settling basin 25 by 25 feet in area, and 7 1-2 feet deep; also two sand filters, each with a surface area of 12 by 24 feet or .0066 acres. The walls and bottom are built of Portland cement concrete. The whole arrangement conforms on a small scale to about the design that would be adopted if a large permanent municipal plant were being built. It is an object lesson to show what can be done toward purifying the river water in its various stages, what the expense of maintenance will be and the best method of operation.

"The water is introduced into the first great chamber through a 6-inch pipe from the pumping main. From this chamber the water can run into the settling basin or through either of two 3-inch pipes to either filter, the object being to run either filter with raw water direct from the river, or with water out of which the gross impurities have been settled.

"The settling basin has a capacity of 33,000 gallons, or sufficient to allow 24 hours' sedimentation with a maximum rate of flow through one filter of 5,000,000 gallons per acre per day. The water from the settling basin enters the second gate chamber from which it can be drawn into either filter. There are suitable overflows for the purpose of keeping the height of water constant during all operations.

"The filters themselves are concrete basins, each having a 4-inch tile drain placed along the middle of the bottom. This drain is carefully laid with open joints on a bed of fine broken stone in a trough made in concrete. On the bottom there is placed three inches of course broken stone of ballast size, covered with a layer of smaller size, simply for the purpose of closing the larger openings. On the top of the broken stone there is 1¾ inches of clean river gravel that has passed through a ¾-inch screen, but which is free from all that will pass through a 5-16-inch screen. On top of this is placed 1 1-4 inches of the sand gravel that has passed through a 5-16-inch screen. The fine broken stone and all the gravel were carefully washed free from dirt and sand before being used. The gravel was taken from the river about opposite Brilliant.

"On the top of the gravel there is placed four feet of sand carefully and loosely put in place. The sand was dredged from the Ohio river a short distance below the confluence of the Allegheny and Monon-

gahela rivers, and is not very much unlike that used at Lawrence, and many other sand filters. The sand was carefully deposited in one-foot layers and each smoothed and leveled. It was allowed to slide in on runs to prevent compacting and settling, and the men were not allowed to tramp on the sand or gravel, but used short pieces of board to walk upon.

"The water as it is introduced into the filter passes down through the sand and gravel into the underdrains and thence out through a 3-inch pipe. The pipes from each filter are brought side by side into a small vault chamber, where are placed gates, gauges, meters and regulators for regulating and registering the quantity and loss of head. In this vault are also the taps for obtaining samples of water for analysis. The water was let into the settling basin on Thursday, July 15, it was allowed to pass slowly into the filters, in order to saturate the sand, on Saturday, July 17. Today the continuous current began to pass through the filters and the first purified water was obtained.

"It is the intention of running this plant night and day until next spring and by that time considerable data will be obtained in regard to our water supply. Bacterial and chemical analyses will be made daily and the branch laboratory is being fitted up for the purpose of doing such work as is necessary directly on the ground. This, however, is only accessory to the permanent laboratory being built on Herron Hill by the Department of Public Works.

"Room has been reserved for mechanical filter plants just down stream from the sand filter and the commission is now considering proposals from mechanical filter companies in regard to the installation of small filters for experimental purposes. It is the desire to test thoroughly all forms of filters, in order to learn what is best to do for Pittsburg.

"Mayor Ford, Wm. Conway, Geo. L. Halliday and other members of the commission, were very highly pleased with the result of the work, and are satisfied, that at last, the plan for giving the city a good water supply has been discovered. Just what the analyses that are being made, however, will reveal, is a matter of conjecture, but the members of the commission are satisfied that when next spring arrives they will be convinced that this system is the proper one.

"According to the present consumption of water in the city about 50,000,000 gallons per day, there would be required a filter with an area of 25 acres. After the filter is once built, it will cost the city but little money as it works automatically and needs but little attention."

DISCUSSION.

H. C. White: I might say in connection with my paper, that I have here a report of experiments made at Louisville by Mr. George W. Fuller, who has charge of the experimental work that is being carried on in this city. We have the report here through the kindness of Mr. Wilson, Secretary of the Engineers' Club of Cincinnati, and Mr.

Charles L. Parmelie, Assistant Engineer of the Board of Trustees, Commissioners of Water Works, Cincinnati, who is connected with the experimental station here. He made an attempt to have Mr. Fuller present to discuss the paper, but as is well known, in matters of this kind—before the report is made—engineers seem backward about giving us information as to what has been done. I presume also that he may have been busy in other directions, and could not be here.

President Gilpatrick: The paper is before you for discussion. May we hear from Mr. Parmelie?

Charles L. Parmelie: I really have nothing to say except that in coming down in the car, it struck me that perhaps engineers generally are not fully aware of the difficulties attending the purifying of water of rivers such as the Ohio. We have ordinarily in the Ohio river from one-fifth to a ton of mud in every million gallons that we have to take up; in other words, to supply such a city as Cincinnati, we have on an average to remove from fifty to seventy tons a day. When you remember that is all very fine mud, you can realize that it is rather a large undertaking to strain it out of the water.

The Chair: Mr. Thomas Boughen is present, and we would be glad to hear from him.

Thomas W. Boughen: I am just here to look on and listen. I had maue no preparations to say anything in regard to Mr. White's paper. I think that as far as it goes, it is all right, but he has shown no results as yet. If Mr. Geo. W. Fuller and Mr. Parmelie would talk, they could tell us a great deal. This is something that I have endeavored to get information on. Ever since I was was seven years old, I have been drinking this Cincinnati water, and it has not hurt me; but there are a great many people who say that it don't hurt a hog to eat slop. When we get accustomed to it, it don't hurt us so bad, yet when strangers come here and get sick and go off with typhoid fever and tell their friends all over the country that they will never visit Cincinnati again, it is about time we did something. I want to say as to these gentlemen, although they won't talk, that they have done excellent work here. They have made a very elaborate and careful test of our water, and from what I understand, they have succeeded in their efforts. I visited the filtering plants of Europe where they use entirely the method of sand or natural filtration. That is called the "European System." The English claim it as theirs; the Germans claim it as theirs; the Dutch call it theirs; none of them say that they do as the others do. They are not like this country. They don't believe what the other does is right, but they do it, and when you come to look them all through, you find they all have the same method, although in different places they have to meet different conditions as to their rivers. For instance, at Rotterdam, on the Main, they have a very filthy stream that is covered by the tide, and it goes up above the settling reservoirs, the settling reservoirs being below the height of the tide. An hour and a half after the tide turns to go out, they open the gates and fill in. At Amsterdam, on the Hague, they take water from

the sand; the town is a sand hill; that water there is as pure as almost any water in this country, unless taken from some very deep body of water; still they put it through filtration nearly the same as at Rotterdam, only for not quite the same length of time. They don't have to settle this water to precipitate it. The same method is followed all through Europe, at Berlin, Hamburg, Paris—well, Paris uses a purifying process through the sand. London uses the sand process. At no place in Europe that I saw have they mechanical filters. The English don't want to do as the Germans or French do. Our Americans seem to want to purify water faster, and hence we have mechanical filters, while in that country they won't use a mechanical filter. I think the report which the gentlemen will make will be a first-class one, and I hope it will be on natural filtration.

C. L. Parmelie: I want to thank Mr. Boughen for his very kind remarks. Our Louisville report has been on the market some time, and the gentlemen present are probably familiar with that. It has been suggested to me, however, that some of you may not be aware of the difference between the so-called "European System" and what is known as the "American System of Filtration." For the benefit of such I might say, in the European method of filtration normally, there is used no chemical at all; while in the American method there is used a chemical. In the European method the water passes slowly through a layer of sand, and it represents an efficiency at different points normally of about 3,000,000 gallons per acre per day; but as Mr. Boughen very correctly says, the American people don't like slow things; so naturally they try to get something that will do the work faster, and Mr. Hyatt principally advocated the use of a chemical which would act something like the white of an egg when put into the water, and coagulate the suspended matter into rather coarse lumps, so they could be strained or filtered out, the straining process being done by a layer of sand, the ratio of difference in rate of filtration being normally about as 3,000,000 to about 100,000,000 gallons to the acre per day. As to the difference of cost, of course the initial cost of the plant is greater in the case of the European system of filtration, but the cost of operation of the American system is greater on account of the chemicals used. That is the essential difference in the two methods. It simply becomes a question of the relative applicability of the two systems on the ground of cost in a great many cases.

A Member: Which gives better results?

Chas. F. Parmelie: That depends upon local conditions. You could not, for instance, use a mechanical filter as ordinarily used with sulphate of alumina in cases where you have nothing to decompose the sulphate of alumina, without adding originally lime to the water. In such a case it certainly would be more advantageous to use the other systems; but local conditions entirely control the solution of the problem.

Thos. W. Boughen: In regard to our water here and the mechanical filter using the alum process, a great many people object to alum; and

we think in a great many ways that if you can get along without those chemicals, as they do in Europe, where they will not allow any chemicals whatever, it would be best. When you have to use a grain of alum to the gallon, 7000 grains to the pound, it means a good many pounds. At two cents a pound, this would cost something over $2 a million gallons, and if we have 50,000,000 gallons, using one grain to tne gallon, the alum would cost, say $100.00 a day, which would go a long way towards paying the interest on the investment of the cost of the other process; but that is to be determined by the commission here. We hope they will do the best possible, even if it costs more money.

REPORT OF COMMITTEE ON MUNICIPAL ENGINEERING.

HOSEA PAUL, CUYAHOGA FALLS, CHM.

Municipal improvements have been vigorously prosecuted during the past year. Not only in the cities, but in every good-sized village, something has been done in the way of opening, grading, paving, draining, sewering, lighting and water supply. In the larger cities there is to be added, the more recent problems of the abolition of grade crossings, the removal of poles and wires, the filtration and purification of water, the construction of intercepting sewers and disposal plants, the collection and destruction of garbage, the creation of parks and an intelligent regulation over the process of platting and expansion.

For the coming year, there are signs of a halt in activity because of financial conditions, as in many Ohio cities, their revenues have not kept pace with their increasing expenses. This is mainly because tax values of real estate, the principal sources of revenue, are adjusted decennially, the last time being in 1890. The effect of all this is that, in some instances, further expenditure for public work is practically impossible, until there is a change of conditions—a new valuation or a new set of laws. This present condition affects the improvements paid for either by general levy or special assessment on a particular locality, as in both cases, there is generally a statutory limitation preventing a rate beyond a certain proportion of the valuation.

I might say that I deem a ten years' interval too long between such appraisals, as however justly and equitably they may be originally determined, many circumstances that canont be foreseen will operate to change them, and values may increase in one quarter and lessen in another, possibly without affecting the total.

Very few of us realize how much has been done in the way of municipal improvements during the last ten years, and I daresay if the statistics were obtained and published it would be a revelation to all

of us. Take the matter of paved streets, for instance, and recall what has been under your own observation, and then consider what has been done elsewhere.

More important than mere increase of quantity has been the great gain in quality. Turn to pavements again, as that of all things is most readily seen, we will notice that the day of the cobblestone is past. We notice by the printed program there are experts to present us papers along these lines, but one point may be touched upon and that is that street railway companies are generally suffered to tear up streets, destroy monuments and finally to lay a rail of a form that is an unnecessary obstruction to travel, all without the interests of the public being protected by engineering supervision.

We can hardly speak of municipal improvements without recalling the splendid record of the late Col. Geo. E. Waring, whose untimely death occurred so recently. The scale of his achievements was so large, he was so ready and prompt to tell us about it, his capacity as an organizer was so considerable that his name and fame will long endure in engineering annals. His redemption of Memphis, so promptly and so thoroughly after its desolating yellow fever epidemic; his grand work in cleaning the streets of New York demonstrating by effective peformance that henceforward if the streets of a city reek with mud and garbage, it is because there has arisen no real and honest effort to cleanse them.

The Cuban war came and victory over the Spanish arms on land and sea was soon achieved. But the hand of death was not stilled. Pestilence more deadly than shot and shell was devastating fair cities and fertile plains. Of all men to investigate the dreadful conditions and suggest a remedy, Col. Waring was the ideal one, and the president sent him. It was a dangerous and a fateful mission and he became a speedy victim to the scourge that he laid plans to conquer, but not until he had rendered humanity a great and a signal service, we might say, the most beneficent and enduring yet undertaken under our newer national policy, and under whose behests no grander life has yet fallen.

There is another problem which is attracting the attention of every thoughtful citizen and which demands special consideration from the engineer, and that is where to draw the line between those things which a municipal corporation ought to do for itself, and those which it may better leave for private initiative, at what point the work for public convenience must stop and that for private profit begin?

Do public ownership and private franchises represent supplemental quantities or hostile and opposing forces that will grapple with increasing earnestness and fight to the death? Is the talk of eventual public ownership of all public activities that we hear so much of, a good omen, or is it revolutionary, socialistic, tending to anarchy, the devil and destruction? These are live questions that very soon no man can ignore, but for the time being the average person will do a good deal of dodging.

But it would be idle to attempt to conceal the fact that just now the sentiment in favor of public ownership is gaining ground very rapidly, and it is also to be noted that changes from private to public control are much more common than the opposite. In the matter of rates in the case of water supply they are generally fifty per cent. higher for private than for public service, and there is an absurdity involved in paying interest and profits on your own gift of a franchise, which is frequently valued higher than any actual investment in plant. Another reason for changes effected and being sought is that private companies are quite likely to confine their operations to the more profitable portions of the work, and decline to furnish other useful and necessary service, which, however inseparable, does not seem to them to be so directly remunerative, or because alien stockholders are satisfied with present conditions, and don't wish to bother with changes.

But whether under private or public control, the multiplication of old and the creation of new facilities, conveniences and comforts will go on and in the building and maintenance of them, the engineer has a great and increasing part to play. He may read history and study the lessons of past experience, he may watch the conditions that arise around him, but he must also look with hope and expectancy as to what the future may bring, must realize that the world moves.

DISCUSSION.

President Gilpatrick: A point that struck my attention as the paper was being read is the matter of the supplying of electric lights to communities in small towns, say of one or two thousand inhabitants, where they already have an electric light plant for the purpose of lighting their streets. Ought such small towns or villages to so enlarge their plants as to furnish incandescent lights for consumers among their citizens? So far as our own little village is concerned, we have an electric light plant for lighting our streets, but we stop there. The reason we stopped there was as much due to my influence as anything else. I was active in securing the plant, and used my influence against an incandescent plant for the supplying of our citizens with light; my reason was that when the streets were lighted I felt that the public, so far as the officials of the town were concerned, had had their necessities met, and when it came to incandescent lighting, it was the business of private corporations to come in and furnish that facility or accommodation.

L. W. Mathewson: Did you have gas before you had electricity?

President Gilpatrick: No, sir. We had a water system, and our power was sufficient to supply us with water by running the plant during the day-time; and we thought it was a poor investment to have that steam power lying idle part of the twenty-four hours; so we added a dynamo to the plant, and furnished electricity for our street lighting; the same steam power answers for both.

Secretary Brown: Would it be a profitable investment for a company to put in a plant and simply furnish incandescent lights?

President Gilpatrick: Not in our town.

J. W. Stump: Isn't it a fact that a good many water and electric light plants owned by some of the smaller cities, at least, are successfully furnishing to private consumers?

F. A. Bone: In Lebanon, we furnish light for both the streets and commercial use. Before we commenced our municipal lighting and for commercial purposes, our gas company had quite a monopoly, and charged $1.60 per thousand for gas; we are now rapidly putting in the light; and they have lowered their rate for gas 20 per cent., and I think they can make dividends yet. I believe the municipal plant has been a benefit to our town; undoubtedly it can be carried on as successfully as water works. I cannot see any difference between the municipal ownership of light and water plants.

President Gilpatrick: Allow me to suggest a point in favor of furnishing of electric light. The incandescent light is perhaps a little of a luxury, while water is a necessity from the standpoint of public health and public safety. There are a good many towns owning electric light plants and water plants. There are other towns of many more inhabitants where water and light is furnished by corporations.

L. W. Mathewson: If a town has already gas furnished at a reasonable price, would it be advisable to change to electricity for private lighting? Would there be any economy to use the Welsbach burner on public lamp-posts, so that the cost of gas would be very materially reduced?

J. W. Stump: In Circleville they are lighting the city with arc lights, and they have been getting about $75 a light per year, and a proposition was made some time ago to the City Council to light for about $67.50 per arc lamp per year for ten years: and some of our business men have made a proposition to the City Council to light the city for five years at $50 dollars per lamp per year; competition is worth a good deal.

President Gilpatrick: I think the electric lights in our town cost us $25.00 to $30.00. We have the large number of forty-three (43), in our small town. There is an arc light at every intersection in the corporation. The village owns and conducts the plant. Our water works cost us $18,000.00, and our electric light plant $5,000.00 more, running them together. Our town has a population of about 1400, not including the student population of about 500 to 600.

J. W. Stump: Is your electric plant self-sustaining?

President Gilpatrick: No. We are taxed to pay for the plant and operation of it. We charge for water to the consumer.

J. B. Weddell: In Shelby the light plant is self-sustaining, and I think a little more than that. So they get their street lighting for nothing; every dollar of expense is paid the municipal owners by incandescent lighting, and more than that. If that is to be taken as a criterion, it would be well for all our towns to own their electric plants as well as their water works.

STREET PAVEMENTS OF LIMA, OHIO.

J. C. CRONLEY, LIMA.

Lima, Ohio, is situated in Allen County, in the northwestern part of Ohio. We are 71 miles from Dayton, the same from Toledo, 131 miles from Cincinnati and 208 miles from Chicago.

In 1870 the population of Lima was 4800, in 1880 7500, in 1890 16,000, and in 1898, according to the school census, 26,275. The rapid growth of our town began in 188—, when Benjamin C. Faurot, in drilling for gas, on the grounds of the Lima Paper Mills, discovered petroleum, thus opening up one of the largest oil fields in the world. This discovery of oil brought to our town three great business concerns, viz: The Solar Refining Co., the Buckeye Pipe Line Co., and the Ohio Oil Co., the first two having their chief offices at Lima, and the latter at Oil City, Pa.

Next to the oil industry, the most important factor in building up our little city has been the splendid railroad facilities, which we enjoy; eight different railroads find their way into and through the city. Thus, after our city became of some importance the subject of street paving began to receive some attention, and in 1893 the City Council passed an ordinance for the paving of the public square with paving brick. The improvement was duly advertised, bids received, and the contract awarded to Horn and Hallwood, at $1.87 per square yard. The City Solicitor, however, in behalf of the citizens of Lima, brought an injunction suit against the contractors, and after two or again awarded the contract at $1.64 per square yard. The work was completed in July of 1894, and is still in very good condition. The material used on the street was Hallwood block, on a six-inch concrete foundation with sand filler.

In 1897 the City Council passed an ordinance for the paving of North Main street with paving brick of block, and after numerous delays the work was let in August of 1897, to Wiles & Son, of Canton, Ohio, for a price which equaled $1.44 per square yard, including all items necessary to the construction of the pavement. The concrete three trials, the work was re-advertised and Horn and Hallwood was foundation was six inches thick, composed of one part natural cement, two parts sand, and four parts of unscreened broken stone. The curbing was six by twenty inches set in cement, and hand dressed. At street and alley intersections the pavement was brought up to the top of the cross walks, making a flat intersection.

This form of intersection is very good where the crossings are convex, but where the gradient of the street is considerable and the crossings concave, the storm water will overflow the sidewalks and inundate the lots adjacent to the street. The street was paved to a

width of 60 feet with a double street railroad track in the center. According to its franchise the Street Railroad company was required to pay the labor necessary for the construction of the pavement within its tracks and for a space of 18 inches on the outside of tracks. The specifications required a concrete foundation of 7 by 15 inches under each rail, in place of ties. The rails being connected by tie bars spaced eight feet apart. After two or three hundred feet of track had thus been laid the street car company changed the manner of track laying as just described, by placing wooden ties at regular intervals under the track and continuing the use of the tie bars as before, and now, after 14 months' use, the street railroad tracks seem to hold up just as well under one manner of foundation construction as the other.

The manner in which the tie bars were used, greatly injured the appearance as well as the utility of the pavement in the tracks, leaving ribs in the surface of the pavement wherever used. The materials selected for the pavement of this street were Townsend block and Assyrian asphalt filler. The other streets of our city which have been paved with brick have all been so improved under the same general specifications that governed the work on North Main street. As we were in the experimental stage of paving, the Council decided to use different brick on different streets, so that that material which gave the best results and most complete satisfaction, might be adopted in future improvements of the same kind.

At the present time the Townsend block and Wassail block show about as much wear in one year as the Hallwood block in four years, with the same rate of traffic. The Metropolitan block were the only brick ever shipped to Lima that were equal in every respect to samples submitted with bids. As these brick have only been in use a short time we are unable to say how the street traffic will effect them, or to make any comparisons with other brick. One of the most serious obstacles in the way of successful paving is the form of rail used by the street car company, viz: a six inch girder. The brick between the rails have an inch crown and are laid even with the shoulder of the rail, while on the outside they are laid with the regular crown of street and to the top of rail. This makes a wedge shaped depression in the track, which acts as a sort of ditch during a rain fall. My idea would be to lay the brick in the track with a crown of one-eighth of an inch, and to the top of the rail with a shoulder in the brick sufficient to leave an inch space between the rail and brick.

The fillers used on the pavements were sand, bituminous grout, tar and Assyrian asphalt. The sand and bituminous fillers have given satisfactory results, while the tar and asphalt fillers have generally been condemned.

Our first asphalt pavement was completed in September, 1897, by the Ayers Asphalt Paving Co., of Zanesville, Ohio. The work consisted of 5300 cubic yards of excavation, 22,300 square yards of concrete and paving covering a space of one mile in length and 30 feet wide. The specifications required the covering of the concrete with

a binder course one (1) inch deep. Upon the binder course, a wearing surface of the quality of Trinidad Lake asphalt was to be laid to a compression depth of 1 1-2 inches in thickness. This course to be composed of asphaltic of cement, 12 to 15 per cent.; sand, 70 to 83 per cent.; carbonate of lime, 5 to 15 per cent.. The contractor's bid was upon Assyrian rock asphalt with a five-year guarantee.

The material which he used, however, in surfacing the street was California asphalt, mixed with 15 per cent. of Assyrian rock asphalt in place of carbonate of lime. The work sold for $1.79 per square yard, including all items of paving excepting catch basins.

This improvement has been open to heavy traffic for more than one year and a half, and seems to be in as good condition as when completed.

In the spring of 1897 the City Council passed an ordinance for the paving of West Market street from Main street west to Cole street, a distance of one and one-eighth miles, with asphalt.

The specifications required that the surfacing material should be Trinidad Pitch Lake asphalt, mined directly from so-called Pitch Lake in the Island of Trinidad, or any other asphalt of equal or superior quality, provided no bid should be received unless accompanied by a sample of asphalt pavement one foot square taken from pavement which was at least five (5) years old. Upon these conditions a number of paving firms competed for the work. The Columbia Construction Co., whose bid was $1.87 per square yard, was awarded the contract, on Trinidad Land asphalt. The Barber Asphalt Paving Co., whose bid was $10,000 in excess of the bid of the Columbia Construction Co., brought an injunction suit against the city, enjoining the same from entering into a contract with the said Columbia Construction Co., setting forth the allegation that the Columbia Construction Co. had not complied with the conditions of the specifications, because the Trinidad Land asphalt was inferior in quality to the Lake. That the specifications required a material equal or superior to the Trinidad Lake asphalt and that as the chemical analysis, as well as the history of the land asphalt in use showed it to be inferior to the Standard, set forth in the specifications, that therefore, the bid of the said Columbia Construction Co. should be rejected; they, the Barber Asphalt Paving Co., further claimed that their bid of $2.12 per square yard was the lowest bid received as per specification, and that the contract should be to them awarded. The real animus which prompted the Barber Paving Co. to bring suit against the City of Lima, Ohio, was not so much for the purpose of securing the contract as it was to condemn the material used by the Columbia Construction Co. The battle now being fairly on between these two corporations, great preparations were made on both sides to "do each other up." The Barber people had a number of expert witnesses. Some gave an extended history of asphalt, showing its use in various cities, the relative number of square yards of each kind of material used throughout the world, and the duration of each kind of pavement. Expert after expert gave testimony in behalf of the

Barber people, going into the origin of the material, followed by an extensive chemical exposition of the merits of the Lake asphalt as compared to the Land asphalt.

The case was handled by the best lawyers in the state, and every effort possible made to show the superiority of the Lake asphalt.

The Columbia Construction Co., on the other hand, with expert testimony, showing that the Lake and Land asphalt were one and the same thing, and that no discrimination should be made between the two materials, combatted every point made by the Barber Asphalt Co. Among the distinguished witnesses for the Columbia Construction Co., was Prof. Peckham.

He had visited the Island of Trinidad and studied the origin of the two asphalts, had analyzed them under every possible condition, had investigated the merits of the two asphalts for a period of years, and after a most careful research on his part, only found a distinction without a difference. He said that both asphalts were produced by the same chemistry of nature, that each gave the same chemical analysis and stood the same tests and would make the same kind of pavement.

Nearly a week's time was taken by witnesses and lawyers before the question was submitted to the court, who, after a long and careful consideration of the case, decided in favor of the Columbia Construction Co., saying that the testimony showed that the two asphalts were in reality one and the same thing. The case was taken up to the Circuit Court, but that body sustained the lower court. So, insofar as the courts are concerned, we are to understand that the Lake and Land asphalt of the Island of Trinidad are of equal merits.

DISCUSSION.

Secretary Brown: How long has this asphalt pavement been finished.

J. C. Cronley: Martin street has been finished only since September 1st. One thing I forgot to mention was the street car rail. The pavement is laid up against the rail. There is a double track part of the distance and along the rail in numerous places the asphalt is broken back as much as 6 to 7 inches, and in places the pavement has raised up and water got down between the pavement and the rail, and when the water froze it raised the asphalt up in some places, I think, 2 inches above the rail. It was suggested that in some places they use brick along the track, but they decided to use asphalt against the rail. The street was nearly level. I think the street ought to have an 8-inch crown where it is 60 feet wide.

J. B. Weddell: Were you using anything but sand filler? Did you have lugs on the brick to separate them?

J. C. Cronley: There was a grove on the brick, but no lugs. The asphalt would get in, but the great trouble was it didn't stick to the brick. People carried the stuff in on their carpets, and they made serious complaint. Harrison avenue was filled with bituminous grout,

a composition of tar, asphalt, sand and something else. It was hard. It cements the bricks together so that you can't pull them apart. It never gets any softer than asphalt pavement. It seemed to be entirely satisfactory.

S. G. Baker: Do you know who furnished the bituminous grout that you say gave satisfaction? Was it a Pennsylvania company?

J. C. Cronley: Yes, sir.

S. J. Baker: We had some experience where they undertook to use that in some of our country pavements, and couldn't get it into the bricks satisfactorily, it was too thick. They undertook to use it on Euclid avenue, Cleveland, and had to give it up there; it formed a regular cake on top of the pavement. Afterwards I tried it. It looked very unsightly, but the great difficulty was, you couldn't get it into the pavement. They claimed to use a composition of coal tar pitch and asphalt and asbestos, ground asbestos, and they claimed it would withstand the heat and would not run. Well, it does seem to stand heat somewhat better than coal tar asphalt and it doesn't seem to run. I don't think you could get any of it in except with lug brick, which we use altogether. I understand we are the only city which insists upon lug brick. We are also the only city which requires 5-inch brick.

J. B. Weddell: I have used, nearly always, the sand filler. A filler may be put in for various purposes. If it must be water-proof, I don't think sand would answer, but as a rule, in the work where we have put in nothing but sand, it stands today as well as any other work that I know of. The cost is about a shilling a square yard less for sand. I have no objection to tar or bituminous grout as a filler, if you can get the material in the place where it is intended to go. I believe from my own experience, and what I have seen on the streets that have been years and years in use, that a sand filler for all ordinary traffic is just as good as any other.

G. A. McKay: In filling with sand, what process do you use to get the sand in? Do you wash it in?

J. B. Weddell: We water our filler and filter it in, throw it on very deep, then broom it in, then we throw some of the water on it, or flood it. I have found that even if you don't get the joints full at once, they will fill up. The sand keeps the bricks from getting too close together, and fills in and makes the mass more compact or solid.

S. J. Baker: In the south of Cleveland they are adopting entirely Portland cement and sand, partly mixed before it goes on the street, Due proportions of cement and sand are properly screened and mixed and ground together, making a sort of cement like the Murphy grout. Instead of mixing it on the street, it is supplied by a company, which delivers it ready-made at points where required for use. It is being used there almost altogether now, and is inspected at the works where it is made, to insure that it is mixed in the proper proportions. They are claiming very good results indeed. I have used a cement filler, one part of Portland cement and one part of sand, which were mixed on the road and used as a grout; and where it was done in the right season

and traffic was kept off, as it should be, we had very fine results from it. On a hill with a very steep grade, it was a question whether brick would not be too slippery. We used lath to separate the brick about 1-4 inch space, to allow a little more foothold, and used Portland cement filler, and it gives a very satisfactory road.

E. A. Kemmler: In regard to cost, I believe at Columbus we have had some figures on street paving that would discount any I have heard here. Two years ago we built one street, paved with Wassal block, at 75 cents per square yard, exclusive of curbing. Our foundation consists of 8 inches of broken stone, into which is rolled limestone screenings, so as to make a hard covering similar to a macadam street; then a 2-inch sand cushion—which, I think, is too much, 1-inch or 1 1-2-inch would be all right—and then 4-inch brick with tar filling. Last year the cost was somewhat higher, particularly on account of the higher cost of the brick; but we have constructed no brick pavements that cost more than 98 cents a square yard; the average is 90 cents. I do not consider the tar filler a proper one, but it is the cheapest we can get. We figure on 10 cents a square yard for the filler, which is less than one of the gentlemen figured—25 cents. In regard to asphalt streets, I would like to say a few words: In Columbus we have practically nothing but Trindad lake asphalt; in one or two instances we used Kentucky Rock asphalt, but the main material was Trinidad Lake. We are, however, going to be more liberal in the future, having prepared new specifications last year. We are going to admit any asphalt, and we are not going to depend upon any inspection at all. It seems to me rather inconsistent to prepare specifications and have an inspector on the place to see the work and condemn the material, if necessary, and then require a five-year guarantee to make the necessary repairs, which may be due to bad material or bad workmanship. I think asphalt streets ought to be considered in a different light from any other kind of material, because the engineer as a rule is not familiar enough with the character of asphalt to pass upon the work properly. While our guarantee up to this time has been five years, we are going to make it ten years, and I think we will get better material and better results. I think a five-year guarantee is too short a time on any street. I think most of the streets that are put down in good practical shape will remain five years without any repairs, and the extra cost on such streets with a five-year guarantee over the one-year guarantee is too great for the difference in results. The contractor gets the benefit of the extra amount charged on account of the five-year guarantee and the risk he takes, while as a matter of fact if he uses good material, and has good workmen, no guarantee is necessary for five years at all. The guarantee then should be ten years, on all streets, and I think with this kind of specification for asphalt streets we will get better work done, and the streets will be more satisfactory at the end of ten than they now are at the end of five years.

MAINTENANCE OF ASPHALT STREETS IN CINCINNATI, O.

J. M. HARPER, C. E.

There have been until within a short time three Asphalt Paving Companies doing business in this city, each owning its own separate plant, two Trinidad lake pitch, and the other the Bermudez product.

The proportions of materials used by the different companies in composing their mixtures are substantially the same, and the material is all laid in the same manner upon a six-inch concrete foundation.

Three to ten years' observation indicates that for durability and wearing qualities, the asphalts named give about the same results. A five years' guarantee is exacted, and 10 per cent. of the cost of the work is retained for that term to enforce the maintenance clause in the contract. Interest is paid upon the amount so held semi-annually, provided the street is in proper repair.

Where the pavement is opened by the water or sewer departments, or by the Gas Company, the street sub and superstructure is replaced by the Asphalt Company holding the contract for the maintenance of the street either under a guarantee or repair obligation, the expense being paid by these different organizations to the Asphalt Company. Trenches made by the Telegraph, Telephone or Electric Light Companies for their conduit systems, are filled entirely with concrete up to the bottom of the asphalt surfacing, none of the original excavated material being thrown back. These companies put in the concrete, but the surface is restored and expense paid as before mentioned.

Where the thoroughfare is trenched by private parties, a permit has to be obtained from the Paving Company controlling the street under guarantee or maintenance contract, and a charge per square yard equal to the original contract price per square yard, plus one per cent. of the same is made and collected from the party making the cut.

Whenever the Street Railway Companies are required by the chief engineer to replace an inferior construction by a heavier and more substantial rail, the work is put under contract by the Railway Company, and the sub and superstructure of the street for a lateral distance of at least eighteen (18) inches outside of rails of track or tracks, are taken up and replaced. The engineer is the sole judge as to how far this lateral work may extend. Occasionally, in order to make proper connection and camber, it is extended to the gutters on each side. Usually the contractor performing this work for the railway people has the contract for maintaining the street, and gives bond to the railway authorities for keeping this part of the work in good condition during the continuance of his repair contract with the city.

The rail generally used upon the asphalt thoroughfares is a grooved six-inch girder, ties being laid upon a substantial concrete foundation and concrete filled in to within two and one-half inches of the top of the rail, the latter being flush with the completed street surface. The asphalt is laid directly against the rail, without any toothing of granite or other material. This works very well in practice. In time, however, very small openings develop between the rail and paving, due to vibration, but more repairs are needed in tracks and next rails than are required upon other parts of the street.

The table submitted includes all of the streets and alleys in this city that are—up to the date of this article, January 16, 1899—paved with asphalt. It contains, I think some information not heretofore published in connection with city reports. In the column giving distance of haul from plants, the streets marked A are upon the hilltops, and are at an average elevation of 275 feet above the general level of the business centers and some 335 feet above the location of the plants, which are all in the vicinity of the river and railroads.

Omitting Central avenue, which was paved when the temperature was very low and with the expectation that the street would have to be repaved in the spring, and all of the hilltop thoroughfares and including St. Leger Place and Hutchins avenue, which were constructed under the suburban specifications; also Spring Grove avenue, which was constructed under an extraordinarily low bid, the California asphalt having been admitted into competition with the other characters of asphalt on this street, and Tusculum avenue, an extraordinary haul, the average cost of original construction of the down town thoroughfares was two dollars and sixty-eight and six-tenths cents per square yard. On the hilltop streets it was three dollars eleven and seven-tenths cents per square yard.

The average expense per square yard for the maintenance of the first fifteen streets mentioned in the schedule for the first term of five years was seven and twenty-four one-hundredths cents ($0.0724) per annum. For the second term of five years it is thirteen and seventeen one hundredths cents ($0.1317) per square yard per annum.

This might be considered a remarkable increase in cost, being nearly double, but it is due to the fact that a period of thirty weeks elapsed between the expiration of the maintenance contracts for the first term and the awarding of those for the second, consequently the thoroughfares, with the exception of Race street, were in a wretched condition.

The average cost of thirty-seven streets for repairs under contracts for the first five years after guarantees had expired is seven and sixty-five one hundredths ($0.0765) cents per square yard per annum. The city engineer of Boston reports that the cost of asphalt patching in that city during the past year was ten and seven one-hundredths cents ($0.1007).

The specifications for repairs prescribe the usual formula for making the mixture and laying the same.

In the case of small repair patches and skimming repairs, the contractor can, with the consent of the engineer, use a hand-roller giving a pressure of 100 pounds per lineal inch of roller.

In repairing the asphalt pavement where cutting out down to the concrete base is deemed necessary, the edges of the openings shall be trimmed down square with the pavement surface. Any depressions in the concrete base which, in the opinion of the engineer, are not of sufficient depth to require a relaying of the foundation, may be filled to the level of the top of the concrete with bituminous concrete, or what is known as a "binder," composed of pebbles screened from gravel, or finely crushed stone, mixed with coal-tar pitch containing not less than 10 per cent. of asphaltum, and thoroughly compacted.

When, in the judgment of the engineer, the depressions in the asphalt pavement surface are not of sufficient depth to require cutting out down to the concrete base, the repair process known as "skimming" may be permitted; provided, however, the existing asphalt be of good quality below the depressions to be repaved. When "skimming" is permitted the top surface will be softened by heating and removed to the required depth, which shall be uniform, and the edges of the openings cut down square with the pavement surface. The sub-surface will then be heated, and asphalt of the specified quality be laid and compacted by tamping and rolling. When completed the repair patches, whether made by cutting out down to the concrete base or by skimming, shall be perfectly united with the adjoining original asphalt, and paved even and true with the same for surface.

No asphalt will be permitted to be reheated and used again, as fresh asphalt must be laid in all cases.

DISCUSSION.

J. M. Harper: There was originally one company in Cincinnati on the work, the Warren-Scharf, using lake pitch; then another company was formed, which was known as the Trinidad, and it claimed to use land pitch from the Island of Trinidad. One tract was laid, and at that time the "land pitch" and the "lake pitch" people came together and consequently used the same material. Afterwards a company was formed called the Bermudez, supposed to use that product, and they bought a very large supply, and it is not yet exhausted. That has been laid on about three streets.

For the last three years only two kinds, the Bermudez and Trinidad, have been laid. The bids for Spring Grove avenue, which I have mentioned in the report here, were received last summer, when the California product was admittd in competition. The street has not yet been improved.

Secretary Brown: How does the cost of maintenance of the land and lake asphalt compare?

J. M. Harper: Well, about the same. Findlay street was paved with Bermudez, and the cost of that for maintenance per square yard is 7 42-100 cents. Bruce avenue was paved with rock asphalt. The

cost of maintenance depends somewhat on the amount of traffic on the street. Race street, laid with lake pitch, probably carries a heavier traffic than any other asphalt street in this city. According to my best recollection of that, the cost for repairs was 10 cents per square yard. There is considerable difference in the judgment of the engineer and the contractor as to what constitutes the keeping of an asphalt street in good repair. Our specifications require that a street should be in good condition before it is accepted at the expiration of the guarantee term. Last summer the first street I went over was Richmond street, in the West End, which has no railroad tracks on it. It is 36 feet, I think, between curbs. I went over it when the street was perfectly dry, no water on it, and I was ready to accept it. There were one or two places in the whole length of the street—it is perhaps one-half to three-quarters of a mile in length—that I thought needed attention. The day after I had been over it, it rained, and the Chief Engineer suggested that I should go over the street again, which I did. I found about sixty or seventy places in it, which I located by indicating as opposite the respective house numbers, and I sent the list to the company that had the street under maintenance contract, and it made them red-headed. They wanted to know if I had sent a sprinkling cart over the street for the purpose of determining the depressions by the amount of water that stood on it. That gave me the impression that that was a good scheme, and I think I shall work it right along, provided nature does not assist me. But the specifications should provide what depth the depressions may be, in order to compel the contractor to carry out what the engineer thinks is right. The fact is, in these repair specifications it ought not to be left to the judgment of either engineer or contractor. The specifications should provide that depressions over a certain depth should be re-surfaced. Of course it is easily seen where the streets show signs of disintegrating, and it is wonderful how fast this stuff goes when it once starts.

J. C. Cronley: What effect do you think standing water has upon asphalt?

J. M. Harper: I think it has a tendency to rot it.

J. C. Cronley: Do you think mud is a bad thing on it?

J. M. Harper: Yes, sir. I think an asphalt surface should be kept perfectly clean as far as possible, and just as little water applied to it as is practicable. Of course, where a street is sprinkled for the purpose of keeping down the dust, if the street is thoroughly swept, there is no trouble about that. The difficulty is here: Although a great many remarks have been made about the manner in which the street sprinklers use asphalt surfaces in flushing them with water, still it seems almost impossible to prevent the attempt to put as much water as they can on the street, because they want to avoid going over it often.

BETTER ROADS AND FREE DELIVERY OF MAILS.

AN ADDRESS BY HON. MARTIN DODGE, BEFORE THE OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS AND THE ENGINEERS' CLUB.

CINCINNATI, JANUARY 19, 1899.

Senator Dodge was introduced by Mr. Schuyler Hazard, President of the Engineers' Club of Cincinnati, and spoke as follows:

Mr. President and Members of the Engineers' Club and of the Ohio Society of Surveyors and Civil Engineers:

I have been greatly pleased and benefited myself today by participating to some extent in the proceedings had by the Ohio Society of Surveyors and Civil Engineers; and I am pleased to be with you in this meeting, and to make some remarks touching the question announced by your President. I would say as a preliminary, that I have for many years regarded the engineering profession as being among those who contribute the most of any class probably to the wonderful increase in the power of production that is so manifest among our people, and at this time in the world at large.

I have seen stated in some scientific publication that the increased power of production apparent at the present time as compared with that which was possible in a simple and primitive time is about in the ratio of 34 to 1. There can be no doubt that the engineering contribution made by your profession has aided more than any other agency in accomplishing this result.

I am more impressed by the fact that half of our people have assembled together in large cities than by any other fact that comes to my mind for consideration at any time. I not only believe that this increased power to which I have referred is explained by the concentration of population, but I believe that the forces that have produced this concentration are unspent forces acting upon the people today; and I speak of it the more at this time, because I think that the road system of the future of which I am to speak briefly to you tonight, must take into consideration this changed condition of the people.

I will call your attention to the fact that, although there is a very great increase in the power of production, that it nowhere appears to any considerable extent, where solitary and primitive methods still prevail. Contrary to the ordinary expectation and to the ordinary conception, the people in the rural districts are not the producers preeminently as they have been accustomed to call themselves; because we know it is the common idea among people in the country that they are the only real producers, and they say that the others are con-

sumers. They are accustomed to look upon all people who live in cities, as somehow living off of the productions of the producers. Now, I regard that as an economic error, and am well satisfied that those people who live in the cities, and who work to any useful purposes are producers even in a higher degree than are those who call themselves "the producers."

As stated, one-half of the people live in cities. I am speaking of the State of Ohio, and of the eastern states, and I may include all of the cities east of the Mississippi river and north of the Ohio and Potomac rivers. The increased power of production only manifests itself when people come together; therefore, it being true that one-half of the people who already have assembled together in these great masses produce far more by reason of that fact, the half living in cities are the greatest producers. I regard all persons as consumers. I don't consider that the conviction I have referred to, which I think exists in the country, is scientific in any degree, nor that it expresses anything more than a sort of traditional error, which I believe to be an exploded tradition even at that.

For illustration refer to the matter of grinding flour. Of the wheat we produce, one-half is consumed in the country; yet the increased power of production is so much by the prevailing method that nearly all of the flour that we eat, is from wheat which has been transferred from the point of production to some point where people are assembled together, and where it is ground and re-distributed; and it is a fact that ten men in a single mill will produce fully as much in a day as a hundred men in a hundred separate mills. This is equally true of a hundred different industries that at one time flourished in the country, but have since been abandoned there. It follows, I think, that the people in cities are useful producers, and as much benefactors of the race as the others who have considered themselves as "producers."

I wish to give you a few reasons why I believe the prevailing condition is rather a permanent one, and that the forces which have produced this condition will maintain it; because if I am mistaken in that part then what I have to say in reference to my belief as to the proper use and improvement of the highway will be of little value.

Until comparatively a few years ago our people were distributed so that by far the greater mass lived in the rural districts and in the adjacent villages thereto; but that at the present time that condition has changed. It has been a sudden change, and it never prevailed to such an extent at any time before.

The three forces which I claim have produced this remarkable condition I will now mention. First of all is the cheap and abundant food. If food were scarce and dear, as it used to be, then those who owned the land and produced the food would be the greatest in numbers; but the cheapness of the food has made it so that a smaller proportion of the people are sufficient to produce enough food. Thus a greater and increasing proportion of the entire population are all the

time relieved from agricultural pursuits, and find employment in other ways. A second factor is the cheapness of transportation; the means of transportation has been cheapened to a greater degree also than was foretold or foreknown, and the like of which was never seen.

Having this cheap means of transportation by which can be assembled the products in places where the people may be; having the cheap food in such abundance to feed the people, we there find two reasons why the people can be maintained in cities. Many people think that the gregarious tendency of mankind is sufficient to explain the congregation of men in cities. I do not at all leave out the gregarious tendency of mankind, but it is not a new tendency; that is only a constant tendency; they have always been thrown together to that extent which conditions would permit. Never until now were the conditions such, with the cheap and abundant food, and cheap and convenient means of transportation; never until now has it happened to such an extent that you would get the increased power of production from people assembled together.

These three are the peculiar and active principles that are drawing and holding our people together; and the gregarious tendency alone will not explain this, because it is not new. If that tendency was sufficient to draw people together and hold them there, they would have so assembled from the beginning of our civilization on this continent. It is a remarkable fact that only within the last very few years has this remarkable change taken place. The forces which have produced and maintained this condition, as I believe, are so far unspent that they will yet act until three-fourths instead of one-half of the people shall be assembled together in a comparatively small number of large cities, and that there will be an economic gain resulting from this. That, of course, is prophecy, but I base it upon facts which to me are convincing.

Now, assuming that this condition has come to stay, in the consideration of the road question or any system of roads to be constructed with reference to this condition, we must make it possible and easy for those in the country to communicate with those in the cities. When the people were scattered throughout the country it was sufficient to have our roads lead out at frequent intervals from each other, to the towns and villages; and it was as good a system as was ever devised for a scattered population; but when that period passed, when the villages became deserted, when the rural population has diminished and this concentration has taken place, my judgment is that the old system of roads is no longer sufficient, and that a new system should be introduced.

For the purpose of comparison, before considering a new system of roads, I desire to refer to what has been done for the other prevailing means of transportation that are in common use in the country.

The cheapest means that we have in the United States is the transportation by steamships upon the deep water of the lakes. At present the average does not exceed one mill per ton per mile. That factor

alone is sufficient to explain the greater rapidity of growth of those cities that are built along the lakes. When the Ohio river and the Mississippi river afforded the cheapest means of transportation, the greatest cities of the continent were built upon those rivers. But when the railroads furnished a still cheaper means than the rivers then the cities not located upon the rivers began to grow, and continued to grow with equally great rapidity. It seems to be an established fact that the cheapness of transportation has more to do with controlling the growth and industries of cities than any other one fact.

In investigating the movement of freight upon common roads by animal power as compared with water transportation, I found that 1200 miles can be covered upon the deep waters at the same cost that five miles can be covered with animal power upon common roads; also that upon steam roads 250 miles could be covered at the same rate, or it costs one-half a cent a ton per mile. The cost in money for transportation with animal power upon common roads is 25 cents per ton per mile. As much tonnage, or more probably, is moved over the common roads as is moved over steam railroads. Many may think that 25 cents is too high. I was astonished when I began to make an investigation and find out how it was. My attention was directed to the matter by the representative of Mexico at our capital at Washington. He stated that the rate of transportation in his country was so high that it kept the rate of wages low. He said that the lowest rate that they ever got in that country over the best roads was 26 cents a mile per ton. He made a very good case in saying that the rate of wages was influenced greatly by the great cost of transportation; because nothing can be produced for transportation unless it can be sold at a high price. And when nearly the whole value is taken up with the cost of transportation there is but little left for the wages of those employed in producing such things. I think that is true in any country; and on seeing that statement of his, and for the purpose of comparison I began to seek information at first hand. There was nothing published on the matter but from my own investigations I was a little surprised to find it was about 25 cents per ton per mile. I kept up the investigation for a number of years and found that it was practically 25 cents a ton for the delivery of goods on the best paved city roads in a level place; then I applied the matter to longer distances, and I found it came out about the same way. In 1896 General Roy Stone, the head of the United States Bureau of Road Inquiry, which place I am now temporarily filling, with a view of instituting original investigation, sent out inquiries to some 1200 different counties in the United States to ascertain from those various sources what the average cost per ton per mile was; also, to ascertain the weight and the distance, and the other factors. The result of this investigation, carried on in nearly all the states, showed that the average cost of transportation per ton per mile on the common roads was, in the eastern states, about 22 cents; in the southern states, 23 cents; in the western and mountain states as high as 32 cents; but on an average, exactly

25 cents. It seems to me that this rate of transportation is wonderfully high, and I think it is more remarkable yet that it has continued so high with but little betterment.

With reference to the other two means mentioned, upon deep water, and upon steam cars, I am sure that it is a fact that we have made a great deal more progress there than any one expected.

I also call your attention to this fact, that the government of the United States has given very great and substantial aid to both of those means of transportation; it has given of public money large sums to deepen water communication between the lakes, and deepen the water in the harbors anu rivers, and by reason of that aid there has resulted a cheapening of transportation to a very wonderful extent.

Also, in the grant of means and bonds to the Pacific railroads they have aided in reducing the transportation very low. While this is true, they have not really done anything to aid us in the different localities in the direction of better roads. Nothing has been done by the government whatever to aid along that line, of late years. They did in the early history of the country; but that was abandoned with the introduction of railroads, and the entire matter has been dormant for a long time until now; within the last few years there is great desire and a real revival in reference to this matter. We are met with the question as to what it is best to do, as to what we can do?

I have undertaken as well as I can to bring forward something that I thought would be beneficial, something that I hoped would be espoused as a popular measure, and that it might receive such aid as has been given to the other means of transportation, and as was given to the canal system in early days. I have been, as I say, preaching the Gospel for a good many years upon that question; and I have now come to the conclusion that the mass of the people are not sufficiently informed to appreciate the economic gain that comes from these changes, so that I am not expecting them to take up any such measures as I once thought they might do; but I am glad to have the opportunity to present to the engineers here my views as to the possibilities of the new system, the economic gain of which will be equal to any system ever introduced; the beneficial results of which will be as great as have come from any of these various means introduced heretofore. I desire to emphasize the fact that there is but little improvement, very little indeed, upon the short haul freight; that is, the haul for which the distance is too short to use steam roads; but at the same time too long to use horses. Bearing in mind the concentration of population, it follows that the productions of a country must be transported a longer distance than when they found a market in every village. For longer distances than from five to forty-five miles it is too long for animal power, and yet too short to use other means so highly developed for long distances, such as the steam cars and steamships.

I notice by looking at my watch that the time has passed faster than I have been aware of, and as it is my intention to leave on the 9:10 train, I will be very brief in closing with the proposition that I

have offered in the hearing of some of these gentlemen before; that is, that the electric car system which is so fully developed in the great cities is easily adapted to other uses, and to be extended for long distances, that is, of thirty or forty miles, just the distance where we lack means of transportation cheaply, and that by so extending we can cover that short distance haul with a light vehicle propelled at little cost, and the service can be such that all productions of the farm, from the smallest package to the largest that they produce, that is, the maximum load that they haul with a wagon, can be taken upon those cars without re-handling and be landed in the markets of this or any of the great cities, with greatly diminished cost. I had intended to give more of the details and how I would carry them out; but I shall have to content myself with directing your minds and thoughts to that, and expressing the hope that you will aid in working out that problem in such a way that it will give beneficial results such as I enumerated. I will refresh your recollection by stating that highways are costing for ordinary improvement from $12,000.00 to $15,000.00 a mile; and I say to you that means of transportation much more valuable than that produced by these horse and wagon routes can be produced to cover all of these intervening spaces without very great difficulty and at no very great cost. Now, as soon as the cheap means of transportation is provided, then the daily delivery of the mail by the United States government becomes an easy matter; it is the wish of the government not to discriminate between those living in the cities and in the country, as they now have to do, in the delivery of the mail; but the cost is at present so great in delivering in rural districts that it is impossible to give the people that service which they ought to have and are entitled to. There is a discrimination now which should be overcome.

Again, with the daily delivery of mail there should be a parcels post established, whereby packages can be sent by means of stamps, as letters are. That matter could be very greatly benefited as a result of this other means of which I speak. The telephone service can also be introduced, and should be, by the government itself, so as to give to those in our rural districts who have suffered so much by reason of the great and unexpected change, some of the means we have in the cities which aid so greatly the value of the productive power of those living in the cities, and which I think is a great factor in shaping the destiny of the people.

I feel that I am obliged to leave my thought in an imperfect and incomplete state. I hope I have made myself sufficiently understood so that you can at least see what I am aiming at.

I thank you exceedingly for the very patient hearing that you have given me.

INTERURBAN ELECTRIC RAILROADS UPON PUBLIC HIGHWAYS.

BY ROBT. E. KLINE, COUNTY ENGINEER, DAYTON, OHIO.

It is the purpose of this paper to discuss the subject, "Interurban Electric Railroads Upon Public Highways," in the light of public interests, with some attention to the various details pertaining to the work of construction and successful operation of lines of this character.

The fact that Electric Railway Companies are beginning to ask permission, and in many cases have already constructed and are now operating their lines upon various highways, a feature which will unquestionably occasion a rapid change in the cost and methods of interurban travel and shipment, renders important the immediate attention of local authorities, especially the engineer, to the end of devising best methods of adapting these lines to their proper place and construction upon our highways.

While the argument may be advanced that electric lines under the management of incorporated companies whose motives are first and last to secure paying investments, and in view of the fact that highways, as public property, were created and have since been maintained solely for public use, should be required to operate upon their own location or private right of way acquired by purchase.

It is maintained, however, that railways of this character completed and in successful operation are first of all public conveniences and can serve this purpose in no location to better advantage than upon the public highways, while the advantage to such companies of free right of way admits their offering to the general public cheaper rates of transportation than ordinary railways.

The advantage of the interurban railway being constructed upon the highway is mainly in the fact that passengers will not ordinarily walk to a steam railroad station when an electric car direct to their destination can be taken at their very door.

The rates of speed obtainable under the present methods of operating interurban lines, however, are not thoroughly satisfactory to the traveling public.

Perhaps a later development of the plan of operation of such railways by employing double tracks will tend to better results.

As a result of the success in the operation of these lines, steam railway companies may be induced to make traffic arrangements with local street railway companies in cities through which their lines extend, whereby by means of the transfer of passengers to and from the local lines at established stations, and the running of interurban trains at as short intervals as safety will permit either upon the present tracks or

upon parallel tracks built especially for that purpose, and by operating the same either by electric or other motive power, a competition on a more successful basis may be accomplished.

This scheme, where practical, will afford increased advantage to the public in the saving of time, where the distances to be traveled are great.

In the formulating of the franchises of electric lines upon public highways in this state, in view of the fact of the inadequacy and even absence of specific laws regulating the construction and operation of such lines, too great care cannot be exercised by the authorities in charge.

The details and terms of every franchise should embody as nearly as practicable all the specific requirements known to be the best, as displayed in franchises previously granted.

Although it is a fact that there has been but little demand upon the engineer for such services in the past, there is a certainty that there will be more or less need of such services in many localities in the near future.

Under the present laws the engineer should be relied upon by the authorities in the respective localities to incorporate such terms and conditions in each franchise granted that will assure the best and most satisfactory results in construction and operation of such lines relative to public interests, and at the same time to impose only such terms as are proper and practical for such work in the interests of the companies, so that no impractical and useless barriers may be thrown against the promotion of such schemes.

The County Engineer therefore is confronted with a two-fold responsibility.

It behooves him to be equipped with a thorough and practical knowledge of such construction with a view to both these interests.

In the past three years of my incumbency in the office of County Engineer, at Dayton, Ohio, it has been my good fortune by way of experience in this work that two lines have been constructed leading out of Dayton with Hamilton and Eaton as their terminal points, respectively, while seven other franchises have been granted for the building of other lines now in project extending radially from our city on the highways through Montgomery county to other cities.

In the building of the two lines named and now in operation my work began with the preliminary surveys, followed by the duties of superintendency of construction in the interests of the county, and as Engineer of Construction in establishing the lines and grades of the railways at all points where the tracks were located upon the highways under my charge as County Engineer.

It has been demonstrated in our locality that such projects have originated with one or more enterprising citizens as the case may be, with or without high financial rating in the community.

By good powers of discernment some have hit upon lines which afford paying investments and in financing their projects have afterwards enlisted the aid of local or foreign capital.

The laws of this state which pertain to the rights to construct and operate interurban railways upon highways are essentially as follows:

(Section 3437) Electric railways have the general right to occupy highways, with proper authority.

(Section 3438) The sole right of granting franchises is vested in County Commissioners or authorities of municipal corporations.

(Section 3439) The consents of the owners of the majority of the feet frontage on pikes are required.

(Sections 3441 and 3443) It is provided that the county authorities shall fix the terms of a grant or franchise.

(Section 3443-8) Companies duly incorporated under the laws of Ohio may construct, maintain and operate Electric Railways upon highways, for the transportation of passengers, packages, express matter, United States mail, baggage and freight.

(Section 3443-13) Such companies shall be subject to the same regulations and have such powers now provided under the laws for street railroads in municipal corporations, insofar as the same apply.

The laws pertaining to street railways applying to interurban railways are essentially as follows:

(Section 2501) No company shall begin construction until application for leave is made in writing to the proper authorities and until permission has been granted and terms and conditions imposed.

Public authorities may renew a grant upon its expiration on terms then conducive to public interest.

(Section 2502) A public notice of such application shall be printed at least three consecutive weeks in a newspaper of general circulation. Companies are required to agree to carry passengers at the lowest rates of fare of existing railways. No grant or removal of franchise shall be for a period longer than twenty-five years.

The public authorities shall not release companies from any obligations or liabilities imposed by any grant or renewal of franchise.

The foregoing comprise in entirety the substance of the terms in the laws of the state pertaining to the occupancy of highways by interurban electric railway companies.

Immediately upon the inception of these schemes, the process of promoters has been, first, incorporation under the laws of the state. Thereafter, the necessary consents of property holders upon the highways and through the intervening villages and on and over the streets of the cities designed as terminals of the route, have been secured.

In a few cases it has been found best to lease the tracks of established lines to secure the most easy and perhaps best entrances into terminal cities.

After the necessary consents have been secured, the same are filed in their original form in writing with the Board of County Commis-

length of the line, so that cars operating in opposite directions are provided with separate power, affording a decided advantage.

The feed wires are without insulation, the money usually invested in this way being used to provide a heavier weight of wire, solely of copper, thereby affording better results in distrtibuting the current.

This line has the advantage of having no competition.

It runs through a beautiful and thickly settled district, passing the Soldiers' Home, New Lebanon, Johnsville, West Alexandria and terminating at Eaton.

Its elegant showing has already proven it to be a first-class and paying investment.

There is but little doubt that single lines from Dayton to Springfield, Troy and Xenia, respectively, will be constructed and in successful operation within another year.

There is no accounting of the possible advantages to be derived by the attending increase and stimulus to business in the city of Dayton in the future growing out of the construction and operation of so many inter-urban railways connecting towns of comparatively large populations, converging as they will to this common center.

It is safe to predict that the already accredited "Gem City of the West" will more deservedly merit that title in the future as tne inevitable result.

In the past decade projects for inter-urban rapid transit have been before the public in various localities throughout the country.

At verious places the construction of such roads seemed practically assured only to be prevented by intervening obstacles or by objections interposed.

In almost every instance in such localities the attitude of the neighboring public has been uniformly one of friendship while the schemes are yet in project.

The requests of contiguous property holders along the lines of location, for leniency to the company in terms of franchises very often come in the form of demands upon the authorities in charge.

In fact, delegations have been stirred to the pitch of indignation where the latter have been disposed to impose so-termed severe restrictions, however essential thy may have been to the future interests of all parties involved.

The position has been taken, owing to the fact that the majority of highways are fenced in to but a width of approximately 40 feet, despite the fact of a nominal greater width upon the records, that highways might be narrowed to the actual width in use and that the marginal strip remaining might be deeded direct to such companies if desired, instead of granting them a franchise.

In the instance referred to an entire community along a certain highway in Montgomery county carried this opinion into execution in form of a petition to the commissioners to narrow the pike from the established width of 66 feet to the width of 40 feet at present in use.

In the meantime an electric railway company had secured options from the adjacent owners along the entire distance providing for deeds to this marginal strip, thereby affording them a perpetual right of way.

The scheme was defeated, being considered unwise in many respects by the authorities in charge.

It was considered that if a railway was to be constructed alongside the highways, restrictions and terms regulating the construction and operation of the same could best be incorporated and put into execution in the embodiment of a franchise.

Furthermore, should this scheme have been carried into effect the company would probably have constructed the line in a measure independent of the various interests of the highway, including grades and drainage, with perhaps less attention to the interests of abutting properties, although immediately adjacent thereto.

They would probably have operated cars without reference to local interests as to speed, and with arbitrary independence as to the location of places of stopping.

Furthermore, this strip of ground being located between the highway and the lands upon the same side, would form a perpetual barrier to the improvement and later subdivision of the same by destroying their property frontage upon said highway.

There are occasions when tracks can best be constructed upon private right of way. It may be in the interest of the public or the company, and perhaps both.

In the projection and construction of these lines attention is sometimes paid to the routes chosen with a view to the pleasure of those who travel.

A very great amount of travel from cities which tends to make these lines a success is in the mere quest of pleasure and pastime, and routes selected with an idea of novelty and boldness of scheme often bear a great part upon the success of such enterprises.

The making accessible to the view of passengers a succession of natural panorama, where such projects are possible and have been successfully carried into effect, has resulted to the advantage named, without materially affecting the distance and speed of travel.

In the operation of street railways in cities it is found unnecessary to consider methods of increasing traffic, but of sufficient practical importance to devise methods of handling successfully traffic already existing.

In the projection of interurban routes, however, for the purpose of increasing traffic, parks and other places affording features of amusement are subjects of practical consideration in the choice of routes.

Furthermore, due attention paid to gaining access either directly, or by connection with other lines, to parks, public and private institutions and features of amusement, and general public resorts, is essential.

A private right of way, furthermore, may often be used for shortening of the line, the avoiding of excessive grades, and the too frequent crossing of other railroad tracks and large streams necessitating heavy expenditures for bridges and attending expenses of the raising of grades and making of long approaches.

At present the usual method of providing a return for franchises upon public highways is that the company shall do more or less work in connection with improvements to bridges, grades and drainage of highways where tracks are laid, and shall give attention to certain necessary repairs of same, during the life of the franchise thereafter.

In view of developments and the experience of later years it is seen to be worth while to consider the merits of the methods of obtaining a return for franchises granted.

First, by experience it is found a task to secure altogether satisfactory results in enforcing such provisions with frequent neglect and very often partial compliance with the terms imposed.

In our experience, while companies have been required to assume the responsibility of restoring the highways to their former condition of usefulness and to make certain repairs necessitated by reason of the construction of such lines, and further, to widen and regrade and gravel portions of the highways at certain points where necessary, a charge in addition thereto of a stated sum between the limits of twenty-five and fifty dollars per mile each year of occupancy of such highways by companies, is imposed as one of the terms of all grants or franchises now in vogue in our county.

The method advanced by some of a county's assuming the responsibility of attending to all improvements and repairs on the highways necessitated by the construction and operation of such railways, and for remuneration, instead of the former method, the exacting of a percentage of the gross receipts of the company during each year of the occupancy of such highway, has not been tried by the authorities in our locality.

This perhaps would be easier of enforcement and attended with better results in the light of public interests and at the same time prove less burdensome to the companies\who at the outset are burdened with great expenditures requisite to the promotion and completion of their lines.

They could more easily make a greater return for the use of the highways when their revenues were assured and that only in proportion to the amount of their earnings.

In fact there are those today who take the extreme position and advocate further, the construction of the entire track system by the authorities in charge, allowing the companies to use the tracks under a lease for a stated period.

This plan would secure beyond a doubt a construction satisfactory to the interests of the public, but it is perhaps too radical in that it is apt to exclude entirely the rights and interests of the companies as to methods and manner of track construction.

This question must, however, receive proper attention and successful adjustment in the near future, as applications for such franchises increase in number.

In late years the developments of electric railways have made many changes in track construction a necessity.

Passengers are found to prefer the comfort and higher speed of larger cars.

To this end the use of the double truck car is becoming frequent, due as well to their easier riding qualities and the better distribution of weight, and the diminishing of the many objectionable effects of high speed against sharp curves.

Substantial tracks are being built not only with a view to prevent undue expense for maintenance and repairs, but likewise with an idea of obtaining ease and comfort to the passenger.

The methods of construction of the tracks of interurban lines are similar to those employed in the construction of the same for the most modern and best equipped steam railways.

The difficulties encountered by the engineer in adapting tracks of this character to conform as nearly as practical to existing grades and conditions as found upon the highway are probably even more intricate than those of the engineer employed in a similar capacity upon ordinary steam railway construction.

Instead of following continuous grades and straight lines it is necessary to exercise the best judgment to locate and construct the road considering all the interests of perhaps a winding and hilly highway and at the same time bear in mind the essentials of successful electric railway track construction.

In city electric railway work there are but few bridges used solely for railway purposes.

On the contrary, interurban roads over which heavier cars are operated in nearly all cases demand the construction of independent bridges for this especial use.

Furthermore, in that tracks should be, and in best practice are, constructed continuously along one side of a highway where single track construction is employed, it is certainly best for highway travel and for the most satisfactory operation of cars that bridges be constructed in similar location.

Many highway bridges of improved design are already in place and are of ample strength for the purpose for which they were constructed.

This affords an additional argument that electric railway tracks should be built upon independent bridges in all cases where the conditions warrant.

To this point in the discussion of this subject the attempt has been made to deal with the methods of construction and operation of electric railways upon public highways in light of the present condition of highway management and control and conditions of construction, taking into account the laws which now exist and the methods that must be

pursued in securing to the best advantage, first of all, the interests of the general public and subserve at the same time the interests of the companies who have assumed to undertake the promotion of such projects.

In view of the recent general demand throughout the country for increased effort on the part of public officials to the end of securing better roads and the fact that the public has reached the point of conviction in favor of the adoption not only of new methods of management of highway construction and repairs, but that in all probability the highway of today will soon be supplanted by a system of roads in management and construction upon a more universal plan, the construction and operation of the interurban electric railroad of the future must likewise be brought to accord with future developments in that direction and should receive a due share of consideration in the inception of the scheme.

With this in view, to secure the highway against useless encroachments not only by electric railway companies, but by all companies operating under franchises, such as telegraph, telephone and steam railway companies, a uniform and comprehensive system of highway management and control throughout the state can be established none too soon to subserve the best public interests.

County authorities are frequently plunged into difficulties and are in many cases helpless and powerless to defend the rights of the general public in the purposes and the uses for which all highways were originally set apart.

Note the condition of a particular portion of a well-established highway in our own county, where it chances to be hemmed in on the one side by the Great Miami river, the established line of a telephone company, and the road-bed and tracks of an interurban electric railway.

On the opposite side are the ever-encroaching banks of a state canal, a telegraph line and the road-bed and tracks of an established railway company.

The pike, as originally established, 66 feet in width, was second only to the river in the time of its location.

In later years, by the encroachment of the river, telephone line and electric railway upon the one side, and the railway, canal and telegraph line on the other, the highway has been reduced to a marginal width not to exceed 18 feet in the average for a distance of approximately 1200 feet.

To prevent the further encroachment of the river on the one side an expensive retaining wall perhaps 20 feet in height has been constructed.

On the opposite side the canal has seen fit to encroach upon the highway year after year to the advantage of the road-bed of the railway on the opposite side, and the local authorities have been unable, despite repeated effort to prevent such encroachment, there being no recourse except by special legislation or expensive litigation.

In fine, it may be stated that the time is at hand, in fact, is now here, when an established and uniform system of highway control back-

ed by state laws sufficient to cope with the powers of any state boards and commissions or corporate companies now existing, is extremely essential for purposes of defense of the highway as against such contending interests.

If the canal, with interests of traffic so trivial as at present, can, as demonstrated, be arbitrary, the steam railway likewise, and in similar manner the telegraph and telephone companies operating under charters and with certain rights acquired from higher authorities than local and municipal boards, the highway of all interests the most general should have a footing in the state on a par with them at least.

The purpose and realization of a systematic and effective improvement of roads in general can best be attained, therefore, by the enactment of a more comprehensive code of laws relating thereto, complete in nature, pertinent to all requirements, both past and present, and thoroughly competent to secure the successful accomplishment of all the ends that indicate their necessity.

DISCUSSION.

C. M. Gordon: How much heavier do they make the bridges which are to carry electric railways and heavy electric cars, and how many pounds to the square foot are they supposed to sustain?

R. E. Kline: Heavy cars, where they run in the neighborhood of 20 to 30 tons; of course, highway bridges are not designed for such concentration of loading. As mentioned in the paper, highway bridges are, a good many of them on improved pikes, of lighter design, yet ample for the purpose for which they were originally constructed. My position is, that in all cases it is better for electric roads to erect their own bridges. Where a combination bridge at a special place is desirable, it might be wise to have the Commissioners and the Electric Railway company act in conjunction, especially where long span bridges are necessary. It may be in such a case economy for both the company and county, if the building of such bridge happens to be under consideration at the time of the construction of the road; otherwise, I would advocate in all cases the building of bridges independently and exclusively.

President Gilpatrick: Are those roads paying?

R. E. Kline: Very largely, it may be inferred, from the fact that other companies are trying to get franchises located.

A. W. Jones: Has the rapid transit company from Dayton to Xenia got a franchise?

C. M. Gordon: They have.

G. A. McKay: The tools are on the ground now.

President Gilpatrick: It has been stated that those electric railway companies are all running behind, not making any money. I would like to know what is the fact in the judgment of the Society as to whether or not they are losing money? Of course the statement I quote is from a steam railway company man.

R. E. Kline: Many of these roads have been taken up by parties without capital for the mere purpose of speculation, who are floating bonds for construction far exceeding actual cost. This accounts for roads running behind. If those bonds were issued for no more capitalization than the absolute cost of construction, they would not have to pay interest on $400,000.00 to $600,000.00 worth of bonds, representing an actual outlay of a far less amount. In some cases the bonds have been practically annulled for non-payment, or through some financial transaction or scheme, owing to which the roads may not pay; but there are but very few roads, even though started poorly, which will not eventually have sufficient traffic to pay a profit upon actual investment. Even roads built through communities sparsely settled, will probably become paying properties much sooner than had been anticipated.

Jay F. Brown: It seems to me that the vital question in this paper is this: Are we to advocate a policy of allowing these roads on the highways, or are we to keep them off the highways? Are we going to surrender our highways to the electric roads to trade on, or are we going to keep something for ourselves? That is all there is in this thing. It can be demonstrated that it is cheaper and better for an electric railway company in more sense than one, to build upon a private roadway, and it can be demonstrated without very much trouble, that it is a bad thing to have them on the highway. I would like an expression from the members on that issue.

President Gilpatrick: Do you ask whether they can be built cheaper on private than on a public right-of-way, when the franchise is given gratuitously?

Jay F. Brown: Yes, and in the whole matter of construction they can suit their own sweet will, when on their own right-of-way, in the distribution of their material, grade lines, running time, and all details of constructing and operating under their own control.

President Gilpatrick: Isn't that a disadvantage to the public rather than an advantage?

Jay F. Brown: That is the question. My opinion is, it is better for them to keep off the road, everything considered.

G. A. McKay: You don't mean they should keep back far from the road, but simply off the road?

J. F. Brown: Keep off the road. Keep simply on their own right-of-way.

G. A. McKay: I am satisfied it would be just as cheap for construction, and perhaps cheaper after they once obtained the right-of-way, because in many instances I know that it costs more money to fill up old ditches, especially where roads are a little narrow and ditches cut out, and there is no room for widening, it really costs more money for construction than it would to buy the right-of-way. About the only land damage would be for the land actually taken. It doesn't seem to me it is any more of a disadvantage to the land owner to have

the track just inside of his field, than to have it just outside of his field, and where it would interfere too much with property in cases of that kind along the road, they could come out on the highway in order to pass valuable property, and then return on to private right-of-way again. Such a plan, it seems to me, would leave the highway in better condition, and the electric railroad company could adopt better grades. The highways could be maintained and improved better, and there wouldn't be that constant menace to the traveling public, nor would the element of damages perhaps, in case of an accident, be so onerous to the railroad company under such conditions.

J. D. Varney: We have in our county one road constructed nearly entirely on private right-of-way; and while I can't give the exact figures, it is about 200 or 250 feet from the public highway; and I think the company feels that they have done a good thing by adopting that procedure. They are very well pleased with the results. While I have been on the road some, I can't say I can express the opinion of all the inhabitants, yet I think it also pleases the inhabitants better. Of course, they can't jump on to a car at every place they wish to, but have to seek it at special passage ways. There is another road in contemplation where they are getting the right-of-way, and that matter is being discussed. I was talking with one of the farmers only a short time ago about the relative advantages of rights-of-way close to the road or back of it, and he was very decidedly opposed to having it run just out of the road and close to it, and I think his reasons were very good, that through the fields the disadvantage did not amount to so much, but as every farm has its farm house, that it would be running right through the front yard in every case where there was a house. He thought it would be much better either to have it run in the road, or go back so as to be behind all the farm buildings. The advantages to the company are those that Mr. Brown speaks of, namely, that they can construct their road on a private right-of-way after their own fashion; they can run the cars in their own way, and have them subject to their own control.

J. W. Stump: I would like to ask Mr. Varney in case they run back 250 feet from the road, if that would not cut up a man's farm in very bad shape?

J. D. Varney: Of course it cuts a farm up some, but the most of the property that that roads runs through is fast coming into the market and just about ripe for cutting up into lots. The right-of-way would, of course, include adjacent sidewalks, a feature which is not regarded as especially objectionable. Of course, although setting back that distance would cut up a farm, it would be much less harmful than to run it beside the pike in front of the buildings. That road that I speak of makes the very best time, and runs its cars more rapidly than any other road in that section, I suppose the best of any in the country. I have forgotten the exact time that they make; I know the first car they ran there made 60 miles an hour.

J. W. Stump: In the cities the electric roads run right along in front of all the buildings, and I should not think it would hurt farm buildings any more than in the city.

R. E. Kline: The attitude of the public in regard to these roads is evidence that the public demand that they be built regardless of where the company wants to put them. The fact that the companies have chosen to adopt the highways is evidence that they are in favor of using the highway. If, as engineer, you were to advocate to a community the use of a private right-of-way when that was particularly against the interest of that community, and would put the road out of their reach or subject them to any disadvantage, you would have the whole community on your back. If you lived in our county you would find that sentiment pretty general. The company that is out after the consents of property owners usually goes after all of them, and the property owners come in for a chance to sign the consents. They build on these roads. Speaking as to better construction in electric work, it is not so essential as with steam roads that grades be constant, or lines be straight. The methods of traveling on electric roads are entirely different, and it is easier for them to overcome a grade than perhaps to build a high fill, or some expensive construction to avoid the grade. They even run over grades as high as ten per cent. in some localities, and think nothing of it. However, that is a little beyond what the grade should be where it is possible to secure it otherwise. The highest grade in our county is five per cent., on a road running south.

A. W. Jones: How is it after a road is built; do the people seem satisfied, or become dissatisfied?

R. E. Kline: Before the road is built they are all clamoring for it, all friends of the road. They are arbitrary in their demands for it; but just as soon as the construction begins and they find the corporation is like all corporations, cold hearted, the public begin to realize they didn't get all that was promised by way of privileges by some of the promoters; and sometimes you hear objections raised; but after the road has been located, it is looked upon like any other improvement to which the country has grown accustomed. The public accept it as a fixture, and are glad it is there; just as we accept any other improvement of the day as a fixture and a necessity.

A. W. Jones: I understand. Speaking of opposition and dissatisfaction, I am reminded of the electric road from Columbus to Westerville. They say it has practically destroyed the pike, and you could not get any one with influence on that road ever to sign a consent.

R. E. Kline: Very poor construction. They made no pretense of repairing the pike.

A. W. Jones: I understand all those roads in Montgomery County are kept that way, so that there is entire use of the pike alongside of the electric road. That was the method I adopted in locating a road which has not been built yet, although it will be eventually. That

pike was very well located. We have put the electric road about 18 to 20 feet from the center, and only had to cross the pike once in four or five miles.

J. D. Varney: One thing I have forgotten to speak of. The companies that are building roads in Cuyahoga County, which are financially strong, are getting out of the public highways. The companies which are financially weak and trying to get along with as little expenditure as possible, are trying to get the right-of-way in the streets, in the roads.

President Gilpatrick: Isn't it a fact that some counties, for instance where Mr. Cronley lives, build their ditches along the pike so that there is but little room for track; for instance, on the road running out of Bowling Green, they have the right-of-way just over the ditch line on private property. The pike is too narrow; the pass would be too dangerous and would frighten a horse, so as to tip over the conveyance.

S. J. Baker: In Cuyahoga County in the course of modern improvement, the county first widened the road which was originally a 60 and 66-foot road. They widened it to 80 feet under a special modification of the road law, which gave the commissioners this right. A suburban railroad company had the right-of-way for a single track on the side of the road, and some switches; but in the improvement of the road the commissioners provided for a double track road in the center, and a 16-foot brick paving on one side for the county road. The other side is to be a graded earth road of similar width, making altogether, with the double track, 52 feet. That insures a double track road through the center without additional cost for widening the road; otherwise, it would have been a very expensive improvement. The advantage of a private right-of-way, as Mr. Varney says, to the electric road is, that they can run at a very high rate of speed, which is availed of by this road to which he refers, the Lorain & Cleveland road. It was constructed entirely upon private right-of-way with iron as heavy as necessary for a standard steam road, and substantial bridges, so that they could, if necessary, operate it as a steam railroad and run at the rate of 50 to 60 miles an hour if they pleased. As a matter of fact they do run at a vastly greater rate of speed than the other roads, and with less liability to accident by frightening teams, etc. This company was, as Mr. Varney says, a strong company. Its organizers were experienced and able financiers, and railroad builders who knew what they were doing. I might refer also to the road from Lorain to Elyria, built by Thomas L. Johnson some years ago entirely on private right-of-way. I understand it was almost a direct line. When he got the right-of-way it was considered a big thing for the farmers—and no great price, I understand, was paid for the right-of-way; but in many cases the property owners were shut off entirely from crossing the road, having neglected to protect their rights when they conveyed the right-of-way; so the road can be fenced from end to end and trains

run at a great rate of speed, which is a great advantage to the railway company. The advantage where they operate in the highway is, of course, as in our county, that they pay nothing in the first place for the right-of-way, and the county builds the bridges as well. The county has in fact erected some very expensive bridges. Of course, if a steam railroad can construct an expensive road-bed, and also pay a high price for right-of-way, these electric roads should be able to make money when they get their right-of-way practically for a song, or for nothing, together with other advantages for which the old steam roads had to pay.

President Gilpatrick: I would like to ask Mr. Kline what regulation is made concerning the stopping places along over one of the lines he mentions.

R. E. Kline: The car stops at all road crossings and at other points not within the limit of a quarter of a mile from a previous regularly established stopping place. They stop at all crossings. They can't be called on to stop under the quarter of a mile limit. We hear no complaint from frightening of horses after the road has been running a short time.

J. D. Varney: That is the experience everywhere. A horse regularly driven along those roads pays no attention to them after six months.

R. E. Kline: They run on half hour or hour schedule, and people who think a little bit can avoid the cars if their horses frighten.

ROADS, THEIR COST AND CONSTRUCTION IN BROWN COUNTY, O.

BY C. M. GORDON.

Mr. President and Fellow-members of this Society:

Having been called on for a report on the construction of public highways, I will, in the time allotted to me, try and give you the system on which we build our macadam roads in Brown county, the cost and maintenance of the ones already built.

At present we are building under the road law of 1898.

After due notice having been published in some county paper, the commissioners call to their assistance the county surveyor, they acting as viewers for the proposed road improvement. If they grant the improvement, then the county surveyor is instructed to draw up plans, specifications and profile and to make an estimated cost of the same. Herewith I will submit the plans, specifications and profile of the Vanceburg and Winchester pike.

PLANS AND SPECIFICATIONS FOR THE VANCEBURG AND WINCHESTER PIKE.

Beginning at a stone on the last side of the Ripley and Hillsboro pike and in the center of the old state road, known as the Winchester and Williamsburg road and at the corner of the land of E. E. Carey and Mrs. Waters. Thence with the center of said road S. 65 Deg. E. 2968 ft., to a stone and stake No. 29—68 feet.

End of first section at stake No. 26—40 feet. Marked with large post on left of road.

Thence S. 65 Deg. 50 Min. E., 2777 feet, to stake No. 57—45 feet.

End of second section at stake No. 52—80 feet. Marked on post.

Thence S. 66 Deg. 30 Min. E., 530 feet, to stake No. 62—75 feet. Thence S. 63 Deg. 30 Min. E. 2100 feet, to stake No. 83—75 feet.

End of third section at stake No. 79—20 feet. Marked on post.

Thence S. 63 Deg. 45 Min. E. 1325 feet, to stake No. 97. Thence S. 62 Deg. 15 Min. E. 4600 feet, to stake No. 143.

End of fourth section at stake No. 105—60 feet. Marked with large post.

Thence S. 64 Deg. 30 Min. E. 300 feet, to stake No. 146 at the Adams county line.

End of fifth section at the Adams county line. Containing 4040 feet. Making in all 2 1-2 miles and 1400 feet.

The road will be built on the line indicated by the foregoing description, except as it will have to be modified by curves at the several angles. Said curves to be suitably adjusted to the tangents they serve to connect and to be laid off by the engineer.

The contractor or contractors will be required to include in their bids the construction of all culverts and bridges on their respective sections and put the same in the construction of the road to the satisfaction of the commissioners and engineer.

The culverts and bridges on said road are located and their dimensions are as follows:

Sta.	No.	Size.	Remarks.
"	9	4 feet	Bridge.
"	14	3 feet	"
"	58	6 feet	"
Etc.	Etc.	Etc	Etc., Etc.

The foregoing described culverts and bridges may not be located at their exact points of location, but may be changed by the commissioners or engineer if they think such change beneficial to the road improvement. All culverts to be capped and paved. The masonry to be done to the satisfaction of the commissioners and engineer. The bridge and culvert masonry shall be constructed of good sound live lime stone, such as shall be approved. None having a thickness of less than 3 inches and 2 square feet of bedding surface, solidly bedded to 3-4-inch joints, without spawls, levelers or cobbles and the joints properly broken.

The walls shall be 18 inches thick for culverts and bridges which have not a greater height than 30 inches, and all culverts and bridges which require their walls to be built higher than 30 inches shall have them built to a thickness in proportion to their height, 4 inches to 1 foot, in heights over 30 inches. The walls of all culverts shall be built sufficient in length to carry the fill where they are located. The bottom of all culverts shall be paved. The paving stone to have a thickness of at least 8 inches, set on edge and properly placed. Slightly concaved from wall to wall. The paving stone shall be protected at the ends of their respective culverts with large rocks. Said rocks to extend the full width of the culverts, including the walls and to project at least 6 inches beyond the ends of the walls of the culverts the way the water flows.

The cap stone of all culverts must be at least 4 inches thick and 8 inches below the subgrade of the roadway and extend at least 6 inches on the walls of their respective culverts.

The gradients of the roadway shall conform to the same as shown on profile to be established by the engineer and in no case shall they exceed 4 feet to the 100 feet, or 2 Deg. 26 Min.

All bridges which are covered with lumber shall be covered with good sound white oak lumber.

The flooring shall be 16 feet long and 2 1-2 inches thick, firmly spiked to the joists. The joists shall be 3x12 inches, 9 joists to a bridge,

and shall extend in length 12 inches on each abutment and shall be placed on wall plates, the same as the flooring. The ends of the joists must be boxed with plank 2 1-2 inches thick, 12 inches wide and 16 feet long, firmly spiked to the joists.

The contractor or contractors shall construct suitable guard rails at all fills, bridges and culverts which are 6 feet or more in height.

BRIDGE MASONRY.

All culverts and bridges must be laid off by the engineer and all excavations for culverts and bridge abutments must be accepted by the commissioners and engineer before any masonry will be allowed placed for the abutments.

The cap stone of all culverts must be accepted by the commissioners or engineer before any dirt will be allowed placed on them. All masonry to be done to the satisfaction of the commissioners and engineer. At least 1-4 of each course of rock used in the above abutments shall be composed of headers.

GRUBBING.

The contractor or contractors will be required to grub, clear and remove all decaying substances, such as logs, stumps, etc., along the road line to a width of 22 1-2 feet on each side of the center line of roadway. And they shall construct the ditches parallel with the center of the road line, so as to give the subgrade the proper slope to the bottom of the ditches.

SUBGRADE.

The subgrade shall be 24 feet wide, smooth, evenly graded, with an 8-inch crown in the center. The contractor or contractors shall have at least 1-4 mile graded to the satisfaction of the engineer and commissioners before they will accept it for the road covering and keep the same in proper condition before they place any material thereon.

The ditches shall be constructed outside of the subgrade and shall be 2 1-2 feet deep from the subgrade, next to the ditch, and 2 feet wide on the bottom; with sides sloping 1 1-2 horizontal to 1 perpendicular. So that when the road is finished it shall be 22 feet wide horizontal at right angles to the axis of the center of the road.

ROAD COVERING.

The road covering shall consist of broken rock and gravel, arranged in the following manner: Ten feet in width, 5 feet on each side of the center, of sledged rock, 8 inches in depth. Broken in fragments not exceeding 5 inches in their greatest diameter. Laid on a uniform thickness over the road bed. The same to be covered with4 inches of napped stone, broken in fragments not exceeding 2 inches in their greatest diameter. Laid of a uniform thickness over the sledged rock and the same to be covered with good clean gravel 2 inches in depth. Making the material 14 inches in depth when accepted by the commissioners and engineer.

The commissioners and engineer shall accept the sledged rock before the contractor will be allowed to spread any napped stone on the sledged rock. When the napped stone is spread and accepted, then the contractor will be allowed to put the gravel over the napped stone. All coarse material in the gravel shall be napped to the required size of the napped stone.

The metal shall be shouldered or cased with earch 14 inches in depth next to the metal and sloping towards the ditches. So it will be 6 inches in depth on the subgrade at the ditches and 6 feet in width from the gravel. Making the road, when completed, 22 feet on top.

The casing shall be got outside of the 24 foot grade.

EMBANKMENTS.

In cuttings, the sides of the cuts and in fills, the embankments shall have a slope of 1 1-2 to 1 and in cuts and on level ground the road bed shall be protected from the injurious effects of standing water by proper drainage. The sides of the road being flanked by ditches at least 2 1-2 feet below the subgrade and said ditches being 2 feet wide on the bottom. The sides receiving the same slope as the embankments. The ditches to be so constructed as to leave no standing water along the roadside. All work to be done to the satisfaction of the commissioners and engineer.

The fills and embankments must be thrown up dry and thoroughly settled and accepted by the commissioners and engineer before any material is allowed on the road bed.

The engineer will give all estimates and in all cases determine the amount or quantity of the several kinds of work which are to be paid for as it progresses. Said engineer and commissioners shall determine the amount of compensation or deduction to be made at contract price when any change shall be made in said work.

The contractor or contractors shall not execute any extra work or make any modifications or alterations in the work mentioned in the specifications, plans, profile, etc., unless ordered in writing by the commissioners.

The engineer will give an estimate the first Monday in each month, if such an allowance be justifiable.

The commissioners and engineer shall in all cases decide every question which can or may arise relating to the execution of said specifications on the part of said contractor or contractors and their estimates and decision shall be final and conclusive.

These specifications are a part of the contract and all matter mentioned in them shall be binding on the contractor or contractors.

Material placed on the road which is not satisfactory to the commissioners or engineer shall be removed by the contractor or contractors at their own expense.

The commissioners and engineer reserve the right to vary these specifications, with the consent of the contractor or contractors in writing, if such change be to the interest of the road improvement.

The road shall be paid for by the lineal rod, measured when completed. The contractor or contractors are to furnish all labor and material at their own expense.

Some of the metal used in the construction of this road was procured from the C., P. & V. R. R., and they delivered the same to the contractors at Vanceburg.

Contract price for this road was $2180.00 per mile.

We have had but 2 roads sold in this county for the last three years that went below $2000.00 per mile. They were the Aberdeen and Glendale pike $1600.00 per mile and the Arnheim and Carlisle pike $1200.00 per mile.

We have no toll roads in this county. The trustees of the various townships levy their own tax for pike repairs, as follows:

Township.	Expenditures.	Mileage.
Union	$4161 02	32 M.
Huntington	1100 34	32 "
Byrd	693 41	16 "
Jackson	525 25	10 "
Eagle	414 88	6 "
Washington	368 26	10 "
Franklin	224 43	9 "
Pleasant	2300 30	29 "
Lewis	1873 85	34 "
Clark	799 40	17 "
Pike	261 24	8 "
Sterling	452 20	10 "
Perry	1571 65	35 "
Scott	493 62	7 "
Green	718 85	15 "
Jefferson	688 10	16 "
	$16,646 80	286 M.

It has been my aim to have the roads well ditched, for if there is standing water along the road it will penetrate the road bed and in a short time spoil the grade.

Fellow-members, there is one thing confronting us and it is a demand made by each and every party who travels the public highways, that is to lessen the gradients of the road. I would not build an improved road with a grade greater than 4 feet to the 100 feet, if I had my way. A grade is permanent and scarcely ever lessened. While the road covering can and is constantly being repaired.

At this age every individual is looking for better facilities for travel, from the great railroads to the bicycle paths, from the rocky alleys to the streets paved with asphalt, from the muddy roads to the macadam pikes.

All of these improvements are entrusted in the hands of the engineer, for it is he who goes ahead and blocks out the way and then brings them to the state of perfection they have reached.

DISCUSSION.

S. J. Baker: One point about the covering stones at culverts; the paper said they are for the most part 4 inches thick.

C. M. Gordon: Yes, sir; 8 inches below the sub-grade. With a culvert 4 feet wide, the cover should be at least 1 foot good sandstone; perhaps 15 inches would be safer. It depends somewhat on the traffic over that road. I just call attention to that. Four inches, unless it is a very narrow culvert, would be entirely inadequate for safety.

J. W. Stump: I guess the quality of the stone would have something to do with the thickness, wouldn't it?

C. M. Gordon: It is of limestone.

S. J. Baker: Probably a foot then would do; a 2 1-2-foot culvert would not need over 8 inches then.

C. M. Gordon: We have never had but one culvert to break through, and that was through some defect in the rock not discovered wnen it was put in. We have had 12 inches of dirt on.

S. J. Baker: I was referring to sandstone.

Geo. H. Hill: In reference to culverts, when I had charge of the roads of our county, we placed two courses of stone, breaking the joints and making it about 8 inches.

Secretary Brown: Why does Mr. Gordon use two sizes of stone? Does he find it cheaper or better to use two sizes?

C. M. Gordon: The lower part of the stone we use sledge rock. It is a little cheaper to sledge than to nap. Then four inches of nap on the sledge, and two inches of gravel on top of that, making 14 inches depth of road.

Secretary Brown: Did you have any trouble from large stone working to the top ?

A. W. Jones: You used too much of that sledge rock. I would make it about 6 inches of sledge and 6 inches nap.

C. M. Gordon: The trouble is the engineer has not always everything to say about it.

S. J. Baker: Do you get your material right there in your county?

C. M. Gordon: Yes, sir; and it is all limestone. We have not got a piece of freestone in the county.

S. J. Baker: We have not any road material in Cuyahoga County. We have to ship in all the road metal. We have no gravel to speak of in our county, and could not build such a road at anything like the price you mention. We can't get gravel for less than 85 to 90 cents a yard on the cars.

Secretary Brown: How is the napped stone broken, by hand or machine?

C. M. Gordon: By hand. That is cheaper than by the crusher. The men that do the work make about 45 to 90 cents a day, and board themselves. They break the stone on the road.

G. A. McKay: Hoy much will a man break in a day?

C. M. Gordon: We have a gentleman from Cincinnati, came up there to break rock; he broke rock all winter nearly, and was paying $2.50 a week for his board. He said he broke rock every day and came out in debt. It is mighty little they break. We have two rock crushers in our county, one in Union Township, and one up in Perry, where they haven't any stone; and the rock crusher tells me that in Union the rock costs them 48 cents a cubic yard at the machine, crushed, and by the time they are hauled and put on the pike, it would increase the cost considerably.

OBSERVATIONS ON PUBLIC IMPROVEMENTS IN CUYAHOGA COUNTY DURING 1897-98.

J. F. BROWN, CLEVELAND.

To watch the gradual development of public improvements in a thickly settled and enterprising community is both interesting and profitable in the way of acquiring experience and knowledge in an engineering way, and as, according to the old adage: "By others' faults, wise men correct their own," correct ideas as to constructive work gradually emerge from the chaos of conflicting theories, and practical results follow the guiding hand of the experienced engineer. In a large city one may find staunch advocates of asphaltum pavements; another thinks brick pavements settle the question, while others pin their faith to block, stone pavement, etc. What is the best pavement for a city street? A question hard to answer. Into the answer to this question enter considerations of material and transportation, labor, repairs, ultimate lasting properties, etc., all requiring much time and careful observation to determine.

Much might be said along this line that would be interesting and profitable to all of us, but the purpose of this paper is to consider some facts in reference to our common country roads, deduced from observations on the work of improving streets in the large cities.

To the engineer who is casting about for information and precedent in formulating plans for improved roads, the work of building roadways and drives around and in the suburban districts of the eastern cities, and the work of the various park boards in the large cities are full of instructive information.

I believe that with the present facilities for transporting material and placing it in position, and the ease and cheapness with which repairs can be made, that roads well constructed of hard material may now be built and kept in repair without being a serious burden on the community.

Some idea of the manner of building a park roadway or drive may be had from the following extract from the specifications in use by the Park Commission of the city of Cleveland.

SPECIFICATIONS.

SURFACING ROAD WITH MACADAM PAVEMENT.

The road bed shall be carefully excavated or filled wherever necessary, and brought to the required sub-grade, 18 inches below finished grade, as indicated by proper marks to be given by the engineer. All ruts and other depressions shall be carefully filled, and all bunches leveled off.

All surplus material shall be removed by the contractor, and placed where directed by the engineer.

All filling required, and not found on the work, shall be furnished by the contractor.

If there shall be any spongy material, vegetable or other objectionable matter found in the road bed, it shall be removed, and the space below sub-grade filled with clean gravel, sand, or other suitable material, and carefully rammed or rolled, so as to make such filling compact and solid, at the expense of the contractor.

No plowing will be allowed in the preparation of the sub-grade.

The road bed shall be truly shaped and trimmed with such crown to the required sub-grade, and rolled with a heavy roller; so that when completed it shall conform truly to the shape and grades given by the engineer. The rolling shall be done when the roadbed is in a moist condition, and if too dry, shall be watered by the contractor.

The surface thus prepared shall be maintained by the contractor until the Telford foundation has been laid.

After the road bed has been prepared a foundation of either Mahoning Valley limestone, sand, blue or other local stone, or blast furnace slag, shall be laid.

The material used in the foundation shall be of the kind selected by the Board of Park Commissioners from the proposal of the accepted bidder. The material selected and used shall be sound and hard and equal in quality to the samples furnished by the contractor and on exhibition in the Engineer's office of the Board of Park Commissioners.

If the selected material be stone, the stones laid in the foundation shall be four (4) inches to ten (10) inches in width, eight (8) inches to twenty (20) inches in length, and not less than twelve (12) inches in depth.

The stones shall be laid by hand in the form of a close, firm pavement. They shall be set on their broadest edges, and lengthwise across the roadway, except in the case of the stone which is under the macadam next to the sides of the road, which foundation stone is to be placed with its longest side parallel with the sides of the road.

They shall be bound by inserting and driving down, in all places where practicable, stone of proper size and shape to firmly wedge them in their proper position. All projections above grade shall be broken off by hand and driven into the spaces not already filled by the process of wedging, and wedging stones shall be furnished and driven until the foundation is full to grade. No wedging shall be done within 25 feet within the face of the work that is being laid.

If the selected material be blast furnace slag, it shall be hard and sound and prepared by being passed through a stone crusher of a pattern approved by the engineer; screened so as to be free from all dust and dirt, and satisfactory in every way to the engineer.

The slag for the foundation shall be of such size as shall pass through a screen with two and one-half (2 1-2), inch round holes, and will not pass through a screen with one (1) inch round holes. The slag for the foundation shall be spread over the surface of the subgrade in at least three layers. Each layer shall be thoroughly wetted, rolled and rammed, and its surface made true and uniform, and at the required grade.

If any of the material be crushed by the rolling it shall be replaced if so ordered by the engineer.

The grade given will be parallel to finish grade and six (6) inches below it.

The broken stone for the macadam surface is to be of trap rock, equal in quality to the sample in the engineer's office of the Board of Park Commissioners.

The stone for the bottom course of the macadam surface shall be of such size as will pass through a screen with two and one-quarter (2 1-4) inch round holes, and will not pass through a screen with one (1) inch round holes.

The coarse screenings shall be of such size as will pass through a screen with 1 inch round holes, and will not pass through a screen with 1-2 inch round holes.

The fine screenings and dust to be such as will pass through a screen with 1-2 inch round holes.

The broken stone is to be delivered on the prepared foundation and dumped on platforms provided for that purpose by the contractor.

The broken stone for the bottom course (of the size and quality herein specified for the bottom course) shall be spread over the surface of the foundation to such a depth that when thoroughly rolled its surface shall be 2 inches below finished grade.

After it has been thoroughly packed by rolling, all the interstices are to be filled with fine screenings, which shall be applied in at least three layers; each layer to be thoroughly worked in by wetting and rolling before the next layer is applied.

A layer of coarse screenings herein specified shall then be applied, and spread to such a depth as will bring the surface 1-2 inch below finished grade. This layer is to be thoroughly rolled, and during the process of rolling coarse screenings shall be from time to time applied, so that when the rolling ceases the roadway is truly surfaced to the required grade and crown. This layer is to be wetted and rolled until the water flushes to the surface.

After the layer of coarse screenings has become compact there shall be spread upon the surface fine screenings, so much as to bring the surface to finished grade when rolled. The rolling of this course is to continue until, by a sufficient use of water, a wave is produced in front of the roller.

Only such teaming as is necessary for distributing the screenings and wetting will be allowed over the broken stone after it is

spread on the foundation, and teaming over the finished surface will not be allowed for at least three days after it is finished.

The roller used on the roads is to be a 15-ton steam road roller of an approved pattern, and the road is to be rolled at each stage of the work until its condition is satisfactory to the engineer.

The use of rammers, and other suitable instruments, is to be substituted for that of the steam roller when necessary.

The amount of work done under the above item ("Surfacing Roadway with Macadam Pavement") will be determined by measurement of the area of the roadway so surfaced, made by the engineer, and the price per square yard paid is to include all work and the furnishing of all materials mentioned above, and all incidental work thereto.

The above specifications are for the constructing of what is known as a "Telford Macadam Roadway," the original idea of which, by using the large stones in the bottom, was to save the labor of breaking all the stones, and to provide good drainage. The engineer of the park board, however, agrees with the writer that with the present facility for getting crushed stone on the ground, it would be easier and cheaper to use stones all of one size or nearly so instead of the course of large stones in the bottom.

So far as I have been able to observe, the most experienced engineers agree on the following propositions:

The sub-soil must be thoroughly drained. The road bed to be made hard and compact (by excavation or rolling with heavy roller, or both). The material to go on in layers not more than 6 inches thick; each layer consolidated.

The top course to be fine material, generally screenings from material free from dust as possible.

The manner of repairing macadam or broken stone roads now in use is as follows: A series of spikes 3 to 4 inches long are inserted in the drum of the steam roller, and the whole road "pecked up" by running the roller over it in this condition. A common harrow is then used to loosen the material to the depth above indicated, a scraper then brings the road to a crown again with the holes filled up with fresh material. A new top course is put on and wet and rolled as at first, and the road is once more in good condition. This proceeding costs about $75.00 per mile including new material.

What is the first cost of a macadamized road? Another difficult question to answer. The kind and cost of material, cost of labor and all items entering into the cost of the road must be considered, and as each case is different, only a very general answer can be ventured to that question.

A first-class turnpike macadam road between two towns where the travel is heavy, might cost, per mile, $15,000.00. A main, cross or lateral road where the travel is much less, might cost $10,000.00 per mile.

For an ordinary X road or for farm travel, $7500.00 per mile.

For single track farm roads; $1000.00 to $1500.00 per mile would make a road vastly better than none.

The above figures are estimated on the usual plan of advertising and letting contracts for road building, and might be very much reduced, perhaps 30 per cent., by the purchase of road making machinery by townships and villages, and doing the work at first cost. An outfit of the necessary machinery for this purpose might be procured for about the following amounts:

For One Stone Crusher, 12x20	$600 00
For One Engine and Boiler	1000 00
For Screens, bins, belting, etc	600 00
For One Steam Roller, Weight 12 to 15 Tons...	2500 00
Total	$4700 00

On all these roads the principle of construction should be the same, the difference in cost being simply in the amount of labor and material put upon it.

It seems to the writer that the Supervisor System of expending the yearly road tax, and the work by the Township Trustees is a great waste of public money and is productive of very little permanent good. To illustrate: A certain town in northern Ohio, not 1000 miles from the metropolis of the state, has many large and deep ditches through it. Every year for the last 25 years, the road tax has been expended in cleaning out those ditches and the mud has been thrown upon the streets; it invariably washes back into the ditches to be again thrown out the next year. The road tax is about $4000 per year, which means $100,000, of road tax money gone, and no permanent though some temporary benefit derived from it.

In the early days of England's supremacy on the seas, the British tars used to sing:

"We've got the ships,
We've got the men,
We've got the money too."

We, also, have plenty of modern road machinery, supplemented with the power of steam, we have plenty of good material and the money to build good roads. and with a reasonable amount of intelligence we should be able to supplant the old Supervisor and Trustee system with a system of permanent work on good roads instead of wasting the road tax from year to year, as is now generally the case.

COMBINATION BRICK AND EARTH ROADS OF CUYAHOGA COUNTY.

SAMUEL J. BAKER, COUNTY ENGINEER.

(Note.—The following description of the combination earth and brick roads of Cuyahoga county is compiled by the secretary from a private letter from Mr. Baker, so that any omissions or inaccurate statements must not be charged to Mr. Baker. At the meeting Mr. Baker exhibited plans and specifications of the work and gave a very complete description of the same to the society. On account of the frequent references to the drawings and to black-board sketches the stenographer could not take a satisfactory report. On account of unavoidable circumstances the voluminous specifications and very complete plans cannot be reproduced here.)

About 16 miles of this kind of road have been built in Cuyahoga county during the past five years and another mile will be built in the spring of 1899.

This work was begun and the earlier parts built under Mr. Jay F. Brown; and Mr. S. J. Baker has carried on the work. The same general plan has been followed throughout, but minor changes in details have been made as experience was gained from year to year.

The plans of the earliest work show a roadway of 32 feet, 9 feet of which, along one side, is paved with brick like a city street, while the other 23 feet is left with simply graded earth.

The brick roadway has brick curbs set flush with the roadway so as to offer no obstruction to driving to or from the earth trackway.

Along each edge of the 32 feet roadway, 6-inch underdrains were placed in trenches 4 feet 3 inches deep and filled with broken stone. There was also an open ditch alongside of the roadway outside of the underdrains above mentioned.

The brick were laid on a bed of thoroughly rolled broken stone or furnace slag.

The plans of the latest improvements show the following changes, which experience shows to be desirable.

The deep underdrains along each edge have been replaced with a single 5-inch underdrain under the center of the brick roadway and only 1 foot below the subgrade. The trench is filled with broken stone. The flush brick curbs are replaced with stone curbs also flush with the roadway. The stone curbs are 4 inches by 14 inches and the brick road 8 feet wide. Open ditches 2 feet deep and 18 inches wide on bottom on each side. From shoulder to shoulder of ditches is as follows: Berm, 2 feet 2 inches; curb, 4 inches; brick road, 8 feet; curb, 4 inches; broken

stone, 6 inches; earth road, 19 feet 2 inches. Total, 30 feet. The top of the crown of the road is at the junction of the brick and earth roadways. The brick slopes 0.2 feet and the earth slopes 0.7 feet.

Four and one-eighth miles of road built according to the last description cost $53,000.00, including engineering, inspection and printing, which together amouted to about $4950.00 or 10.2 per cent. of the final estimate. Engineering which included a survey of the road and the preparing of all maps, plans, specifications, etc., and the superintendence of construction amounted to 7 per cent. of the total cost, inspection was 2.8 per cent. and printing was 0.4 per cent. of total cost.

The average cost per mile of road was $12,800.00. The work was done under two contractors, thereby increasing the expenses for engineering.

There was done on the road about 45,000 cubic yards of excavation, costing $6400.00.

The above averages and per cents may be taken as the averages for similar roads in the county, although the Lorain road, three and two-thirds miles long and now nearly completed, will cost about $16,000.00 per mile, with the brick pavement 16 feet wide or nearly twice as wide as the other roads of the county. This is partly due to the lower price bid for the excavation and also by the use of 4-inch brick instead of 5-inch brick. The foundation used on the Lorain road has been chiefly crushed furnace slag thoroughly rolled and is giving perfect satisfaction.

The theory of these combination roads is that the traffic will largely go on the clay road in good weather and on the brick in bad, thus saving both as much as possible and using both under the best conditions for its use. The brick roads have given excellent satisfaction and are standing up well. There is rarely a complaint made in regard to them.

DISCUSSION.

S. J. Baker: We have a great deal of grading in Cuyahoga county. We have to do some pretty heavy work in order to reduce the hills and make as good grades as possible; that enters largely into the cost of improvement. My rule has been not to exceed a maximum of 7 per cent. on any bill. We have hills on some of our country roads of 14 to 15 per cent., but that makes very heavy work. We follow the road absolutely, of course, making curves at the angles.

Secretary Brown: I suppose when you come to a hill on the surveyed route and find that you can't go straight up it, you make some slight change by putting in a couple of elbows, thus climbing the slope on a diagonal line? By thus lengthening the road, you may help the grade very materially.

S. J. Baker: You could not go outside of the 60-foot road.

Secretary Brown: Change the roadway.

S. J. Baker: We haven't done that. We took the road as we found it; it is such an undertaking to change the line of a road, although there is a provision by which you can do it, I don't think that has been done

in a single case. We keep the brick roadway parallel with the side lines; we have varied some, but as a rule run just as we would with a city street, running the sides of the road parallel a certain fixed distance from the center line, and just according to the cross section.

F. A. Bone: In Warren county we followed the custom of making roads at reasonable cost, the cost of nearly all our roads running at $1000.00 to $1200.00 a mile, and the result is I don't suppose there are more than 1 or 2 per cent. of the farms in our county that have not pikes in front of their doors.

S. J. Baker: There has been great complaint by the farmers that they could not haul loads over those hills in our county, that their produce would get in bad condition, and they cannot haul much of a load on account of the steep hills. You can't figure it, the best that you can do, without getting a maximum grade of 7 per cent. We had a large amount of grading and heavy cutting. We have cut as much as 20 feet in some hills.

J. M. Harper: In what way was it paid for—by the issue of bonds?

S. J. Baker: There was a special road law in Cuyahoga county, and a general tax on the duplicate of one-half mill on the dollar in the city and a mill and a half in the townships, which produced about $90,000.00 a year. The bulk of it goes on the city pikes.

G. A. McKay: In our county (Green), we have been doing considerable work for the last six years in the way of changing roads in the hilly sections of the county. The Commissioners and Trustees are asked to do more of that work than they feel able to do—but we have been able to improve a good many of the steep grades by changing the road, sometimes paying damages, and so saving a good many thousand dollars in the long run. In one instance we had a road on a grade as high as 18 per cent. We changed that road by lengthening it about 200 feet and made it a 7 per cent. grade, costing $500.00 for the grading. It would have cost much more to have cut the hill down to a like grade, and that was clear out of the question. In another case we changed a long hill that was considered dangerous, to a 6 per cent. grade at a cost of $1000.00 for property, damages and the re-graveling. The gravel, of course, we had very handy. In doing this sort of work curves can be run in and followed around the hills, making side cuts. The extra distance doesn't count for very much when you take into consideration what can be hauled over such grades. People are very much pleased with the result. We have been building some stone roads, and never used over 10 inches to 12 inches of broken stone in the center of the road and tapering down to 5 inches or 6 inches on the edges. That makes a very good road if taken care of until it becomes compacted by travel.

Secretary Brown: It seems to me that the grades on these roads are really a very important matter. I am a little surprised to see Mr. Baker using a 7 per cent. grade on that kind of road. I have had a little experience in road building in one of the very rough counties of

the state, Lawrence County, where it is very broken and hilly, the hills being from 200 to 400 feet high. The roads run over these hills with from 8 per cent. to 25 per cent. grades, roads from 12 per cent. to 15 per cent. are quite common. Some years ago I re-located a number of those roads, and my memory is now that in no place did I use over a 5 per cent. grade over those hills, but the roads were very crooked. Of course it usually lengthens the distance slightly, but saves time; because you can travel so much faster than over the old steep roads where it was necessary to walk, going up and down hill. The roads were all established, and in a number of places we had to change the location of the road, which was done with little or no expense. The work was being done under a turnpike commission, under the general turnpike law. I don't think there is any difficulty in getting grades down to 5 per cent. in the state of Ohio, and it seems to me very important to do this. It seems to me that the reducing of gradients is of the greatest importance in tne building of good roads.

A. W. Jones: I have this winter taken a ride around the suburbs of Cleveland, and out into the adjacent country. I came to the conclusion that it would be harder to get good grades there than in the hilly counties in the southeastern part of the state. Land is 50 times as valuable as in southeastern Ohio, and the re-arrangements of alignment would interfere with present dwellings and land boundaries so much, that you could not change the road any way at all without its cos.ing a great deal for right-of-way. I agree with Mr. Weddell as to the necessity of building roads at prices that will not tax people too much. I believe we have built roads probably a good deal cheaper than any others in the state, because gravel is to be had conveniently in several parts of the county, and where gravel is not found, stone is; and labor is also very cheap. Still, I must say the contractors have not made anything on the work. They have built first-class roads from $600.00 to $700.00 or $1000.00 a mile. The latter figure was for a graded road bed, 20 feet wide, with 5 feet and 7 feet ditches on each side, and the middle of gravel or broken stone. We used only 4 1-2 cubic yards to the rod. We made it 10 feet wide and 10 inches thick in the middle, and 6 inches on the edges. Some of these roads are the main roads leading from the county seat, Chillicothe. The levy for pike purposes never exceeds, and has not for several years, over $15,-000.00 a year; and there has never been a year that we haven't built more miles of new pike than we had thousands of dollars in the levy.

J. M. Harper: I apprehend Mr. Weddell's idea in the construction of improvements of this character, as to non-reduction of grades, is a construction for the present and not for the future. The time is rapidly approaching when horse power will be a thing of the past, and vehicles will be operated by some other motor than the horse; and in that case it is decidedly advantageous to have just as light a grade as you can. The principal thing in the construction of these roads is the grade. That is the primary object to be secured, to get the grades as

low as you possibly can. It would be better to build a less proportion in length of road, and build it for all time to come, instead of doing it merely for the present.

G. A. McKay: To my certain knowledge in our county there are a great many short steep hills along some of the main roads that have actually cost more for maintenance in the last 25 years than it would cost to cut those hills down to a 3 per cent. or 4 per cent. grade. Our County Commissioners now hesitate a good while before they make a grade of over 5 per cent. On any road which you might call a main traveled road, they cut them down just as low as they can without making the cost excessive.

J. M. Harper: Don't you find on those steep grades that material wears out much more rapidly than on a level? (A voice: "Washes away.") Not only that, but it is much more difficult for a horse to get a footing, and that loosens up the material, and consequently it washes off.

REPORT OF THE LEGISLATIVE COMMITTEE.

W. B. GERRISH, OBERLIN, OHIO.

To the Members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen: It is not possible for the society to undertake any aggressive work this year, as there is no session of the General Assembly, and we do not even know who will be members at the next meeting.

It, however, will be a good time to take account of stock and lay plans for the future

As a preliminary, I should state that I have not had an opportunity for a personal interview with any of the members of the committee and the views herein expressed are entirely my own and anything that is "off" should not be charged against any of the other members of the committee.

Of the work accomplished in the past, there is one bill for which every citizen and especially every engineer should be profoundly thankful and that is the law requiring all plans for sewerage and water supply to be approved by the State Board of Health.

This law is vigorously enforced and is a potent means of burying hundreds of the short-sighted, half-natured or positively dangerous plans which otherwise would live to curse the communities where they were made.

If we should follow the example of Massachusetts and have one engineers on the board instead of all doctors, it would be for the benefit of all parties interested.

Ohio is one of the very few states which has such a law, even Illinois has not as yet such a provision and it is a subject constantly before the Engineering Society of that state.

This law, it will be noted, is for the public good, but incidentally it is a benefit to the engineering profession.

An inquiry for suggestions for needed legislation of Mr. Samuel J. Baker, county surveyor of Cuyahoga county and member of this committee, brought the following reply regarding "legislation concerning the county surveyors, or other surveyors or engineers employed on public work, it seems to me," he says, "that there has been an abundance of legislation, but not of the right kind. There are any number of laws, imposing duties and responsibilities on us, but not one which I know of fixing any compensation at a decent figure. The pay per day remains the same as it has been for the past 50 years at least, viz: $4 per day on some work and $5 on other, with $1 a day for helper, while the price should be at least $8 and $2 respectively. Here in Cleveland we get for

private work at least $10 a day when using one helper, plus expenses. Why the county or state should expect to get work done at just one-half what it costs private parties is a conundrum I have never heard answered. Also the pay of viewers on road openings, etc., should be just doubled as well, that is, made $3 per day instead of $1.50. You cannot expect to get the right kind of men to give such work their attention without better pay than they now receive. As it is, nine-tenths of their work has to be done by the surveyor."

This is certainly legislation which should be amended and deserves the attention of the society.

It will be noted that it is for the good of the public that the compensation for engineering service to the county should be fixed, but as at present it works a hardship upon the engineering profession, it should be changed.

I would like to say a few words upon that perennial subject of making engineering a closed profession. This subject has been up for years, not only in Ohio but in other states, and so far as I can learn there is not a state in the Union where such a law has been passed. This to my mind, is due to the fact that the people have not been educated to see the need of such a law.

Before law and medicine were made closed professions every person who was about to employ a lawyer or a doctor, if he wished to make sure that he would not be imposed upon by an ignoramus had to individually look up a man's education and ability.

This was too great a burden for the individual, and the state was asked to undertake the task for the public benefit. Incidentally these professions were elevated and derived much good from the law, but the fundamental reason for the law and the only grounds upon which the legislature could be asked to take action was because it was for the public good. One or two hundred years ago, in England, it was customary to pass laws for the special good of the various trades and professions regardless of public interests, but that day has long since passed and now no one can hope to make a lasting success in any legislation which cannot be shown to be for the public weal. While the various bills presented by this society would doubtless tend to the public good, the arguments presented have laid the stress upon the good to the engineering profession with an incidental good to the public. In my humble judgment we will never get any successful legislation until the stress of the argument is reversed.

A closed trade, and it was closed almost wholly from outside influence, is that of plumbing. The individual employers got tired of being imposed upon by incompetent men and the public health was injured by reason of the poor work of these men. So the State Board of Health took means to have a law passed requiring all plumbers to pass an examination to show that they were capable of doing good work. The trade of the plumber is incidentally helped, but the reason for the law was the public good.

But to consider only professions requiring a higher education. Suppose that chemists or bacteriologists should ask that theirs be made closed professions. It would be of no avail to show that it would benefit their professions; they must show that their employers—the public—would be benefited.

You will notice that the employers of doctors and lawyers and also plumbers are nearly all private individuals who have not the means of ascertaining the qualifications of those they wish to employ, while the employers of engineers are largely railroads and political units. Of these the railroads can look out for themselves--money considerations being sufficient to keep them supplied with competent engineers.

Counties and villages are the ones which suffer most from incompetent men. The instances cited here where men have been elected county surveyors who never set up a transit is sufficient proof of this. Many of the delegates who voted for these men in the convention knew perfectly well how much or rather how little they knew regarding engineering, still they wanted them because of party interest or political pull, and they made their choice with their eyes open. Any law which proposes to step in and override this popular demand will be difficult to enforce to say the least.

To my mind the public must be educated to the need of better engineering before we ever have a successful law on this subject.

There was one measure presented to the last legislature and it will come before the next, which should receive the hearty support of every member of this Society, and this is the bill providing for a topographical survey of the state. Last winter the bill passed the senate, but did not get before the house; next winter the campaign will be begun earlier and it is hoped will be successful.

Engineers are best qualified to show the public benefits to be derived from such a survey. The arguments were ably presented to the Society last year by Prof. A. A. Wright of Oberlin and he will be glad to furnish printed matter upon the subject if applied to. Every member of the Society should post himself upon the subject and make himself a committee of one to interview the senator and representative from his district. As an appeal to the pecuniary interest of the profession we should bear in mind that the survey calls for an expenditure of $400,000.00, one-half to be furnished by the state and one-half by the general government and almost the whole to go to providing for the salary and expenses of the engineers of the state.

DISCUSSION.

J. C. Cronley: As to the compensation of county surveyors: I know they are allowed $4.00 a day and mileage while doing county work. In our county they pay no mileage on ditches.. In some counties they do. You can count on the County Engineer getting about $5.00 a day if he can put his time in. There ought to be a law passed which would make the duties of the surveyor more explicit. I have always

been in favor of a salary, and there ought to be no perquisites or fees. We are ourselves to blame for the position in which we find ourselves and the light in which we are regarded by the public, whereby our compensation is not commensurate with the duties and responsibilities imposed upon us. An effort should be made in the direction of compelling persons who announce themselves as candidates for the office of County Engineer to show some proof of their qualifications in the shape of a license or otherwise.

Secretary Brown: There is one matter touched upon in the report which I would like to hear discussed, viz: The topographical survey. The matter was laid before the Legislature last winter and passed the Senate, as stated, and was then lost in the House. It will probably be brought up again. It seems to me that the members of this Society, as well as all surveyors and engineers of the state, should be thoroughly posted upon it and should work together in its behalf.

C. M. Gordon: It is the duty of each member who is a surveyor in this state to work for securing such a survey.

J. D. Varney: Mr. Brown asks an expression of opinion, and I will express mine as decideuly "forninst" it. My objections to it are simply as to the question of cost.

Secretary Brown: Would you be guided at all by the experience of other states, what other people think of it who have adopted a similar plan, the way common people look at it, etc?

J. D. Varney: Of course such things as that would have their weight, but I would not regard myself as being bound by other people's opinions.

J. W. Stump: As to the topographical survey and its relation to us as engineers, Mr. Varney thinks if the War Department wants it, or the Geological Survey wants it, let them get it. I am of this opinion, they will get it and we will pay for it, too. I think it is the duty of engineers to look out for themselves. If we can get something by asking for it, and we know that our neighbors are doing the same thing, why should we stand back and look on? I believe in helping ourselves and can not see that this will be anything opposed to our interests; therefore, I am in favor of it, if carried out properly.

J. B. Weddell: As the law now stands the County Commissioners, if they have any work to do along the line which requires the services of an engineer, are compelled under the law (if the law is constitutional, and it has never been decided otherwise), to employ the County Surveyor to do their work. In some counties County Surveyors are not fit to do any kind of work, not even common, plain land surveying. I have known Commissioners in such cases to say: "Why, we can't employ that man, and we are not permitted to employ any one else. We have got to let the work go, because in employing him there is nothing gained."

I have been thinking for 20 years that the office of County Surveyor ought to be abolished. (Hear! Hear!) I have been County Sur-

veyor myself for a great many years, and I believe this, that it is a profession in which men ought to stand before the public upon their merits. In the first convention this Society ever had, a cry went up from a number of members that we ought to increase our salaries, we ought to have better prices. Now I felt that to be a mistake at the time. The thing to do is to have a standard of qualification. Engineers and surveyors should stand an examination and get a diploma or license from a board that is appointed and constituted by law.

A. W. Jones: I think Mr. Weddell struck the point exactly when he said the office of County Surveyor should be abolished, and as long as the laws are as now, we shall have very incompetent surveyors, that is, many of them. I am very much opposed to paying them a salary. The method of choosing County Surveyors is wrong. No one should be allowed to run for office unless he possesses the necessary qualifications, and the only way to determine that would be to make engineering a closed profession.

R. E. Kline: I think the position taken by Mr. Weddell is attacking this thing from the wrong end entirely. I am of the opinion that county surveyors should be elected, and under the law that they receive the work that is done under the county commissioners; and furthermore, that they should be paid salaries ample to provide good men. When the public know they are putting men in these positions and are paying them well for it, and then in the face of that elect poor men who do poor work, the work ought to be done poorly, and in the end the people will pay for it, and they will eventually elect good men.

A. W. Jones: The better a man does his work, the more he will be scratched the second time he runs.

R. E. Kline: I believe the office of county surveyor with the appointing power of the commissioners as it now is, is just as it should be.

J. C. Cronley: It don't matter whether county surveyors are elected or appointed, provided they possess certain qualifications. I have often expressed myself in favor of appointment, yet I don't know that that is right. I am in favor of making even a candidate show up proper qualifications before he can be placed on the ticket. It is our own fault that things are as they are. If we would agree among ourselves, as every other profession does, we would amount to something. I am in favor of doing something.

President Gilpatrick: I am rather disposed to agree with much that was stated concerning the abolishing of this office. The Board of Commissioners have it in their power, or do sometimes exercise their power, to do about as they please in the matter of giving out the work, and that right in the face of laws passed governing that.

J. W. Stump: As to abolishing the office of county surveyor, I don't know as I am very much opposed to it; at the same time if it is proper to abolish that office, it is just as proper to abolish the office of city engineer, because their work is of just as much importance to look after, and often more so.

A. W. Jones: I don't mean to abolish the office, but abolish the present method of electing the surveyor, and giving him work, whereby it is necessary for him to have a political pull or he will not be favored.

F. A. Bone: I was county surveyor twelve years. It is about nine years since I was in office, and since then I have been working as contractor for bridges. I am in favor of the surveyor being elected, not appointed by the commissioners especially. He is more independent. If he is appointed by the commissioners and boards, where they appoint their own engineer, he is almost always their tool entirely; while where he is elected, if he has the mind to be a man and knows his business, he is independent and can do the county much good.

H. C. White: Receiving his office by appointment makes the surveyor feel under obligations to the appointing power. That is the trouble with the city engineer's office, he is appointed by the mayor; if he doesn't stand in pretty well with the mayor he is liable not to be appointed as engineer. Therefore, I think that the election of the surveyor is the better method of selecting him, but I do think he should possess certain qualifications before he could be named as a candidate on a ticket.

S. J. Baker: What is the status of legislation in regard to the qualifications required of engineers and surveyors in this state?

Secretary Brown: Nothing whatever required.

S. J. Baker: Hasn't the Society taken that up in the past?

Secretary Brown: Yes, sir, many times and dropped it on account of opposition from surveyors and engineers.

J. D. Varney: I am in favor of abolishing the office of county surveyor. I think we would be better off without it, and that the discussion here indicates that the gentlemen don't understand the legal status of the county surveyor at this time. There is no legal obligation on the commissioners to employ the county surveyor to do anything.

President Gilpatrick: The law enacted last winter requires commissioners to employ the county surveyor on ditch and road work, and everything but bridges.

J. D. Varney: There are just two things that must be done by the county surveyor which no other surveyor can do. One is the surveying and making descriptions of land sold for taxes. The other is in case of the loss of monuments, to preserve evidence of the location of those monuments and lines from them, the county surveyor can be called in. He is the only one who can be called in to take testimony to be preserved in relation to that, so that that testimony can be used in court when the surveyor is out of the jurisdiction of the court.

J. F. Brown: I think the office of county surveyor might just as will be wiped out for all the good it does. It is simply in the nature of sworn testimony, and that is all there is to it.

LAND SURVEYING.

G. A. McKAY, XENIA.

The land surveyor in Ohio during the first part of this century was a very important factor in our civilization. He marked out the boundary lines of the possessions which were to be made the future farms and homes of the people of this great state. These surveys have become the basis from which all subsequent surveys and subdivisions have been made.

In what is known as the Virginia military district of the state the original surveys were made in a very irregular and indifferent manner, some overlapping on previous surveys, and others leaving large gaps or gores between them. In the congress lands or that part of the state laid out in sections much more regularity exists, but even in these many discrepancies are found. The principles upon which all surveying operations are based are exact; and if it were possible to apply them perfectly, land surveying would be an exact science in fact, as it is in theory. The practical application of these principles, however, are only approximations approaching perfection to a greater or less degree, depending on the character of the country to be surveyed, equipment and skill of the surveyor and his assistants. The original surveys were made with common compass and chain, and, judging from conditions now existing, they were made in a very hasty manner. Such surveys perhaps answered their purpose very satisfactorily at that time, when land was of little value and a few acres, more or less, was not considered of much consequence. Subsequent surveys made for the purpose of subdividing these into smaller tracts and farms, are somewhat better, but even these are often merest approximations in both angular and linear measurements, with controlling points fixed only in a very temporary way, or were referred to witnesses that have long ago passed away with the clearing up of the lands. In some sections, however, we find the farms are fairly well monumented with good and permanent corners, but as the country gradually became cleared and opened up to view, it was discovered that lines that had been considered and described as straight generally have angles in them. This is not surprising or difficult to explain to any one with experience in common compass surveying, and familiar with the measuring chains of even rather recent date and used by some surveyors, some of which I have known to vary from the true standard as much as six inches. The county surveyor of my own county (and not so many years ago, either) discovered that his chain was 12 inches too long and made a note of the fact in his note book, but made no statement of the length of time since it had been tested for length. In the work previously done with the compass, lines were generally produced

by needle readings without reference to back sights, and the inability of the surveyor to set his needle twice to the same reading, has been a fruitful source of error. The constant change of the magnetic needle from the true meridian, together with diurnal variation, has further complicated matters, rendering the points fixed by such surveys, unless permanently marked, uncertain and difficult to locate by remeasurement of angles and lines. The proper interpretation to be put upon descriptions that are vague and uncertain, and to retrace such surveys often taxes the ability of the surveyor to the utmost. In performing this duty the surveyor exercises to a certain extent the office of arbiter between adjoining property owners in determining their lines. Consequently he should be a man of sterling integrity. His only desire should be to do justice to all parties concerned. When it is evident to those who employ him that he is such, his findings and decisions are seldom appealed from. The surveyor should remember that the strict application to the case in hand of the angular and linear measurements called for in the descriptions are not always the ones that control, but the points, stakes, monuments, etc., or, where they were originally located, if by any means this can be ascertained, are the ones that govern. A disregard of this point sometimes brings surveyors into disrepute, and even ridicule, involving whole neighborhoods in disputes, which often end in a costly litigation. Under such circumstances the courts have perhaps done a wise thing in holding that original monuments or points should control course and distance, otherwise there would be a great tendency to unsettle and disturb many of the old and recognized corners now in existence.

A description reading as follows would undoubtedly be held by the courts to be valid: Beginning at a stone in the east line of A's land near the mouth of a branch, thence eastwardly to a stone near two white oaks; thence southwestwardly to a large white oak and maple; thence northwestwardly to the beginning, containing about four acres of land, more or less. Descriptions similar to this are not uncommon and will illustrate the point that I wish to make, and that is this, that it is not the course and distances, nor area, that controls, but the intention of the grantor to convey all the land bounded by lines joining the points mentioned in the description.

Under such circumstances it is the plain duty of the surveyor to carefully investigate every source from which information may be obtained and govern himself in accordance with the facts presented in each case, remembering that even an old fence is sometimes better evidence of where a corner should be than any measurements that can be made with a standard chain or tape. It does not redound against the credit of a surveyor to admit that he cannot take a chain of standard length nd make his measurements check with those made with a chain of unknown length. In such cases measurements are of little value in determining where the true corners should be, except by ascertaining in some manner the proper allowance to be made for variation in measurements and prorate them. Even then such a method will not always

give satisfactory results, in which case a pick and shovel vigorously applied will often settle the point by unearthing an old monument, point of a stake or evidence of one. If nothing be found, however, after measuring, prorating, digging, question witness if any, either under oath or without it. The surveyor in sense becomes both judge and jury and as soon as he can agree with himself he should fix the corner, and if he be wise, and there is an old fence in the vicinity that has long been recognized as the line (and perhaps never disputed), he will find in favor of the fence. The legislature of this state passed an act prohibiting surveyors from testifying in any of the courts of the state, or before arbitrators, respecting the survey or measurement of any lands unless such surveyor make oath if required that the chain or measure used by him was conformable to the standards of this state. A similar statute was also enacted requiring surveyors to correct their instruments to the true meridian where such meridians have been established. If these acts had been complied with and the proper comparisons and adjustments made, I have no doubt that it would have caused a marked improvement in surveys. There being no other penalty except to disqualify the surveyor from testifying in court, these acts seem to have been universally ignored. We need some new acts upon the whole subject of surveying with sufficient penalty attached to them to insure their observance. On account of lack of precision, and the vast increase in the influences that deflect the needle from its true position, such as railroads, telegraph and telephone lines, wire fences, etc., and the degree of accuracy required in many surveying operations renders the common compass inadequate to the present needs of the surveyor.

The surveyor of today should be equipped with an improved transit with verniers reading to single minutes, and variation plate for the purpose of shifting the compass box until the needle reading will correspond with the true meridian. With such an instrument, a good standard tape and other necessary outfit, he is prepared to do fairly accurate work. All angles should be measured to single minutes, using the needle as a rough check. Either the deflection or interior angles can be measured and the error of closure can be ascertained in a minute's time after completing the survey, by simply adding together all the angles to see if they make the required number of right angles for such a polygon. The difference, if any, will be the instrumental error in the survey. By assuming the needle course on some line, where several readings agree to be correct, the bearings of the remainder of the lines can be readily deducted from the angles measured, without fear of variation from local attraction or other causes. A method much in favor with the writer is as follows, when beginning a survey (where local attraction is not likely to effect the needle), set the verniers to zero and the needle to true north and south, and read all the bearings to single minutes direct from one of the verniers, using the needle as a check only. When the survey is completed the amount of instrumental error in making the survey can be ascertained by simply taking another reading on the first course run. Random lines can be corrected from

such a survey as in common compass surveying, and where no obstruction occurs between points, the instrument need only be set at every other point in taking the bearings. After one familiarizes himself with such a method the work can be done almost as rapidly as with common compass, and where combined with careful measurements will give results surprisingly close in balances and actual area. With a traverse table for distances up to 100 and for every minute of arc., such as R. L. Gurden's, the work of calculating the contents is not increased over that of the old method. Subdivisions can be made from such a survey with facility and assurance, either in the field or in the office. Surveys made in this manner with bearings or angles measured to prominent objects, such as steeples on churches, corners of buildings, or other points, from some or all of the corners, and properly recorded, will enable future surveyors to retrace the work with certainty. When some such method as above described, or perhaps a better one by determining the true meridian astronomically shall be adopted, and a statute enacted requiring land surveyors to pass an examination before a competent board of examiners before they are allowed to practice. Then and not until then will the land surveyor in this state receive the respect and standing before the public that he deserves.

DISCUSSION.

A Member: I would like to ask what method Mr. McKay would recommend as the best and quickest for obtaining the true meridian.

G. A. McKay: I do all my work from the county meridian; that is, I test my needle by the meridian and use the declination so found in all parts of the county. We have an established meridian in the county, and I take my instrument to the county meridian about once a month, and aim to go there at about the same time, about 10 o'clock in the day. I have had sometimes occasion to change instruments, and I find that there is considerable difference in the needles. One needle may vary from the true meridian 30 minutes, and another one may vary as much as 45 minutes. I depend more upon measuring my angles with the vernier.

J. M. Harper: How lately have you taken the variation and how much was it?

G. A. McKay: In the last thirty days. At our place it is 30 minutes east. The line of no variation is between our place and Columbus; it is west of Columbus.

E. A. Kemmler: Do you put the date of every deed in every plat you record?

G. A. McKay: Yes, sir; the date of the survey; another thing I do, I keep all my original calculations; I have blanks for that purpose and file them away and put the name of the party for whom the survey is made and date on that.

E. A. Kemmler: Do you put the variation on that also?

G. A. McKay: No, simply state that the bearings refer to the meridian of the county, established.

E. A. Kemmler: Wouldn't it be a good plan to record the variation at the time you make the survey?

G. A. McKay: I record the variation in my record book. I note it every time I make any change in my declination arc.

J. M. Harper: Doesn't the statute require you to note the variation of the magnetic meridian on any plat you make?

G. A. McKay: Yes, sir. In order to comply with the statute you must put it on the plat.

J. W. Stump: That is only required of county surveyors, isn't it?

J. M. Harper: No. It applies to all, without any distinction.

R. E. Kline: The law requires all surveyors to have their instruments tested by county surveyors.

G. A. McKay: I procured a standard steel tape from the United States Coast Survey, and requested surveyors to bring their chains in for test. I found some of the chains which surveyors were using in the county as much as six inches too long, old link chains.

E. A. Kemmler: I am a little out of date on declination. I knew what it was three years ago; the declination at Columbus was about 20 minutes west; I should say it was about 30 minutes now.

J. W. Stump: It is 33 minutes to 35 minutes at Circleville .

President Gilpatrick: Do you mean by the instrument you use?

A. W. Jones: Needles vary.

MEMBERSHIP

HONORARY MEMBERS

NAME.	BUSINESS.	RESIDENCE.
Frost, George H	Manager Engineering News	New York City, 154 Nassau St.
McFarland, R. W	Civil Engineer	Corning, Perry Co.
Mendenhall, T. C	Pres. Worcester Polytechnic Inst.	Worcester, Mass.
Orton, Edward	Professor in Ohio State University	Columbus, Ohio.
Thompson, Benj	Civil Engineer	Chattanooga, Tenn.

ACTIVE MEMBERS

NAME.	BUSINESS.	RESIDENCE.
Abernethy, C. F	Surveyor	Circleville.
Allderdice, W	County Surveyor	Warren.
Amsden, Lewis A	Surveyor and Civil Engineer	Ashtabula.
Andrews, E. L	Assistant City Engineer	Lima.
Atkinson, J. W	Sup't of Roads and Ass't Eng'r, N. P. & O. R. R.	Galion.
Ault, Edward S	Civil Engineer	Marion.
Bachtell, Samuel	State Board Public Works	Columbus
Baker, Samuel J	County Surveyor	Cleveland.
Bartholomew, Geo. W., Jr.	Treasurer Buckeye Cement Co.	Bellefontaine.
Boalt, Eugene E	Ass't Eng'r in Charge of Sewers	Cleveland.
Bone, Frank A	Civil Engineer and Surveyor	Lebanon.
Bowen, B. F	Surveyor and Civil Engineer	Columbus, 28 East State St.
Bretz, A. C	Surveyor	Lancaster.
Brown, C. N	Professor Civil Engineering, Ohio State University.	Columbus.
Brown, Jay F	Surveyor and Civil Engineer	Cleveland, 205 Cuyahoga Bldg.
Burgess, C. H	Civil Engineer and Contractor	Cleveland, 89 Euclid Ave.
Cantrell, G. W	Civil Engineer	Brooklyn.
Cellarius, F. J	Assistant City Engineer	Dayton, Room 8 City Building.
Craig, Samuel	County Surveyor and Engineer	Wapakoneta.
Cronley, J. C	County Surveyor	Lima.
Davis, John B	Civil Engineer and Land Surveyor	Cleveland, 29 Euclid Avenue.
Davis, C. S	Chief Eng'r Massillon Bridge Co.	Toledo.
Davisson, F. M	Surveyor and Civil Engineer	West Manchester.
Denison, L. B	Civil Engineer	Delaware.
DeWitt, Chas. E	County Surveyor	Port Clinton.
Dickey, E. P	Civil Engineer	Pittston, Pa.
Dillon, L. A	City Civil Engineer	Hamilton.

NAME	BUSINESS	RESIDENCE
Dowler, John W	County Surveyor	Troy.
Dunn, Wm	Civil Engineer	Zanesville.
Evers, Wm. H	Deputy County Surveyor	Cleveland, 91 Chatham Street.
Fraker, L. B	Civil Engineer	Bowling Green.
Gates, Harry M	Civil Engineer	Columbus, 25½ North High St.
Gerrish, W. B	Sup't Water Works and City Eng'r	Oberlin.
Gilpatrick, Jno. L	Prof. Mathematics, Civil Eng. and Astronomy, Dennison Univ'ty	Granville.
Gordon, C. M	County Surveyor	Georgetown.
Gyger, George R	City Civil Engineer	Alliance.
Hanlon, J. A	Civil Engineer	Coshocton.
Hanlon, Wm. B	Chf Eng.C.L. & W.R.R Co., Min. Eng.Pitts.& Wheel'g Coal Co.	N. Philadelphia.
Harper, J. M	Civil Engineer	Cincinnati, Richelieu Building.
Harvey, L. B	City Engineer	Marysville.
Haseltine, Edwin D	Civil and Mining Engineer	Youngstown.
Hill, George H	Civil Engineer and Surveyor	Milford.
Howe, C. S., Ph. D	Prof. Math. and Astronomy, Case School of Applied Science.	Cleveland.
Huston, Samuel	County Surveyor	Steubenville, 601 North Fifth Street.
Jackson, E. S., Jr	Civil Engineer	Elyria.
Jones, A. W	County Surveyor	Chillicothe.
Judson, Chas. A	Sup't of Water Works	Sandusky.
Kemmler, Edw. A	Assistant City Civil Engineer	Columbus.
Kinnear, Josiah	Civil Engineer.	Columbus, 652 East Long St.
Kearfott, Wm. D	Manager for H. R. Worthington	Cleveland.
Kline, Robert E	County Surveyor	Dayton.
Lander, Frank R	County Draftsman	Cleveland, 821 Marcy Ave.
Laylin, John	City Eng'r and County Surveyor	Norwalk.
Lewis, Harry J	Civil Engineer, General Practice	Pittsburgh, Pa., Times Bldg.
Lillie, F. M	City Civil Engineer	Youngstown.
Loofbourrow, E. C	Civil Engineer	Lorain.
McKay, G. A	County Surveyor and Civil Eng'r	Xenia
McDonald, H. W	Sanitary Engineer	Galion.
Maetzel, Henry	County Surveyor	Columbus.
Miller, John W	Assistant City Engineer	Sandusky.
Morgan, Arthur L	Ass't Eng. M. of W. C. & M.V. Ry.	Zanesville.
Munn, M. A	Civil Engineer	Springfield.
Myers, W. E	Civil Engineer	Kenton.
Newberry, Spencer B	Mgr.and Chemist, Sandusky Portland Cement Company.	Sandusky.
Nicholson, George B	Chief Engineer, Queen & Crescent Route.	Cincinnati, N.W.Cor. 7th and Elm St.
Payne, John W	Assistant City Civil Engineer	Akron.
Paul, R. S.	Civil Engineer	Akron.
Paul, Hosea	Civil Engineer	Cuyahoga Falls.
Peters, C. J	Civil Engineer	Tiffin.
Pfouts, O. W	City Engineer	Alliance.

NAME	BUSINESS	RESIDENCE
Pratt, W. H.	Gen. Mgr. Universal Constr'n Co.	Chicago, Ills.
Renick, Seymour	Civil Engineer	South Bloomfield.
Seitz, D. W	County Surveyor and Civil Eng'r	Ottawa.
Sherman, C. E.	Ass't Prof. of Civil Engineering. Ohio State University.	Columbus.
Snow, C. H	City Civil Engineer	Elyria.
Stattelman, G. R	Civil Engineer	Dayton, 37 Washington Street.
Strawn, J. B	Civil and Sanitary Eng. Con.Eng. Water Works and Elec. Light.	Salem.
Strehler, Alfred	Assistant City Civil Engineer	Cleveland.
Stump, John W	County Surveyor	Circleville.
Turner, F. M	City Civil Engineer	Dayton.
Vance, Charles F	Civil Engineer and Contractor	Troy.
Varney, J. D.	Civil Engineer and Surveyor	Cleveland, 53 Public Square.
Weber, Harry L	City Civil Engineer	Richmond, Ind.
Weddell, John B.	Civil Engineer	Mansfield.
White, Homer C	City Civil Engineer	Warren.
Wilson, Wm	City Engineer	Niles.
Wonders, Jas. C	City Civil Engineer	Bellefontaine.

ASSOCIATE MEMBERS

NAME.	BUSINESS.	RESIDENCE.
Beckman, Louis	Manufacturer of Eng. and Surv. Instruments.	Toledo.
Danheiser, Jos. M	With Eugene Dietzgen & Co.	Chicago, Ills.
Lucke, Chas. E	Mgr. of St. Louis Branch, Keuffel & Esser Company.	St. Louis, Mo., 708 Locust St.

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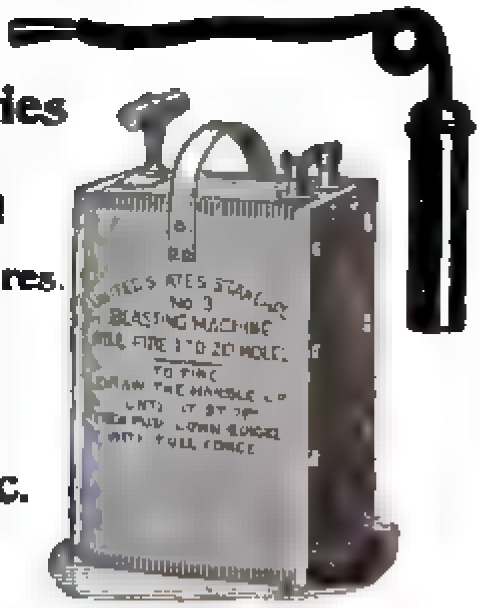

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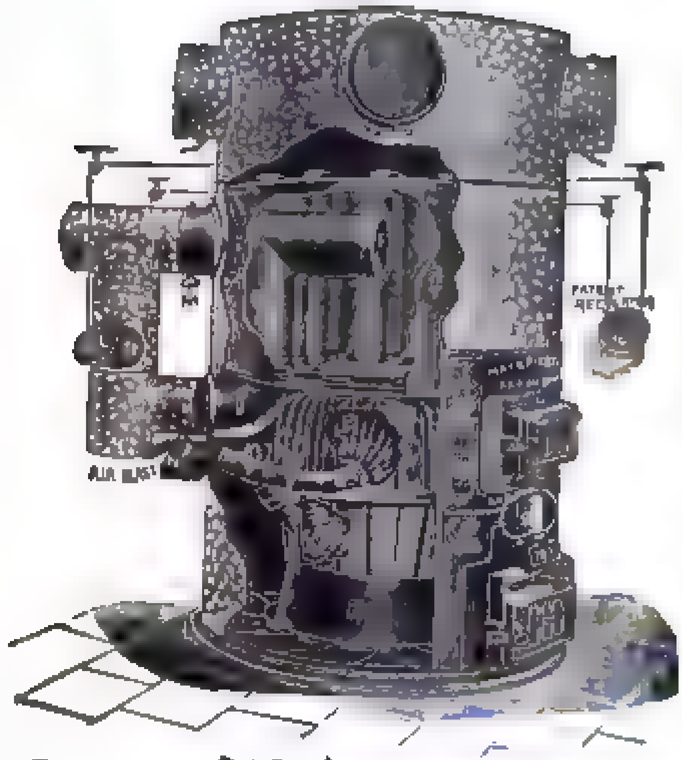

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